POWER

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To the Passing G. M.

By James T. Beard, Jr.

I am talking to you, Mr. Manager Man;
I have things on my mind; that is why I began.
Just give me my say—and then give me the can
If you want to.

In the big world of business you're called a success
And your factories cover the world, more or less.
Well, my hat's off to you, in a way, for I guess
You deserve it.

I have seen your big works up the river a way;
It's an up-to-date place, but it's truthful to say
That you're losing real dough on that plant every day
That it's running.

You are proud of your plant? I don't blame you a bit.
With the latest equipment and everything fit
You have made the mill pay and you've made quite a hit
With the bosses.

But you're proud of yourself, and that sticks in my crop,
For you're wasting real money by failing to stop
Up the leaks in your steam plant and all through your shop
Up the river.

One-fourth of the coal that you burned up last week
Was just wasted—yes, wasted—by many a leak
And it might quite as well have been dumped in the creek
Or the river.

Now, although you are clever at passing the buck
To the coal or the men, you are down on your luck.
When it comes to excuses you're just a lame duck,
And you know it.

I have worked with your men and I'm ready to say
They're the humanest men with the humanest way;
They will do what you tell them, for you hold their pay
And they know it.

So it's right up to you—I am telling you straight—
For the trouble is not with the coal or the grate;
But the trouble's with you; you are 'way out of date.
Do you get me?

You are wasting our coal; you are not playing fair.
It's the country's resources, marked "Handle with Care;"
And you charge up your waste in the cost of your ware,
And we pay it.

You have laughed to yourself that we're suckers and boobs.
What you lost on your steam we have paid for, like rubes,
And we pay for the scale on your boilers and tubes.
We've been easy.

Mr. Manager Man, you are gumming your game;
We are wise to you now and we know you by name;
You have outlived your day; you have outlived your fame.
You are done for.

That man right behind you is taking your place;
He's alive to the problems that he has to face;
He is fully equipped for the gruelling race
Of the future.

It's the edict of fate, Mr. Manager Man,
That the fittest survive and that you get the can.
And you knew the sad fact long before I began.
Now I'm finished.

Remodeling SUCTION GAS MAINS *Anheuser-Busch Brewery*

By Robert H. Karl, M.E.

The refrigerating system at the great Anheuser-Busch brewery, which occupies seventy city blocks in St. Louis, had a rapid growth. Soon the multiplicity of ammonia-compressor piping demanded remodeling it so as to provide mains to facilitate operation and to effect greater economy especially by better insulating the piping. It was an interesting job, and Mr. Karl, the engineer, tells how it was done.

ABOUT four years ago it became evident that something had to be done with the ammonia suction-pipe system at our Ninth Street refrigerating plant. All return gas-pipe mains were very old and in bad condition, and a large increase in the refrigeration load was contemplated, which made radical changes imperative. The first refrigerating machines were installed in 1882, this being one of the first concerns in the country to utilize refrigerating machines on a large scale. The original installation was brine circulation. About 1890 more refrigerated space was added, the brine system discarded and direct expansion installed. From that time to the present the plant grew very rapidly, and additional refrigerating machines were installed from time to time as they were required, until it became one of the largest refrigerating plants in the country, having a capacity of 2000 tons and serving 10,000,000 cu.ft. refrigerated space.

This of course involved many changes, and it was apparent from the mass of return gas-pipe mains from the various stockhouses, etc., to the refrigerating machines, that no very serious attention was given to obtain an efficient pipe layout. Whenever additional stockhouses were added or machines installed, pipe connections were evidently made where most convenient, with the result that it finally became the worst-jumbled mass of pipework to be found anywhere.

This resulted in serious losses. Only a small part of the pipework was insulated, and that was in poor condition. The sizes of the mains were entirely too small for the load, which resulted in very high gas velocities, from 9000 to 12,000 ft. per min., which caused serious drops in pressure, etc.

Cause of Greatest Losses

The most important losses were caused by the fact that the entire work had to be done at a low pressure and temperature, while the largest portion of the load is high suction-pressure work. The reason for this is that in connection with the brewery, there is a 150-ton ice plant which operates, normally, at 15 lb. suction pressure in the ice-freezing tanks, and all stockhouse work, which is all high-temperature work varying from 31 deg. F. to 40 deg. F., which should have been done with high evaporating pressures. Because all the suction mains were connected together and operated under one pressure and temperature, 15 lb. and 0 deg. F., any attempt to operate at a higher suction pressure in the stockhouses would result in the high-pressure suction gas from the stockhouses, etc., backing up into the ice-tank suction pipes and into the ice-tank coils, which of course would cause an increase in temperature in the ice-tank coils, seriously interfering with the capacities of the ice tanks, so much so that it was impossible to get anywhere near the tonnage that should have been obtained from the ice tanks, considering the coil and can surface.

Another serious cause of trouble and loss was that it was very difficult to keep liquid from the compressors, especially when the beer coolers were working, and in order to avoid this as much as possible, this work also had to be done at low pressure. There was also a serious shortage of liquid-ammonia storage capacity, which would cause the compressors to have to handle highly superheated gas at times, which also entailed

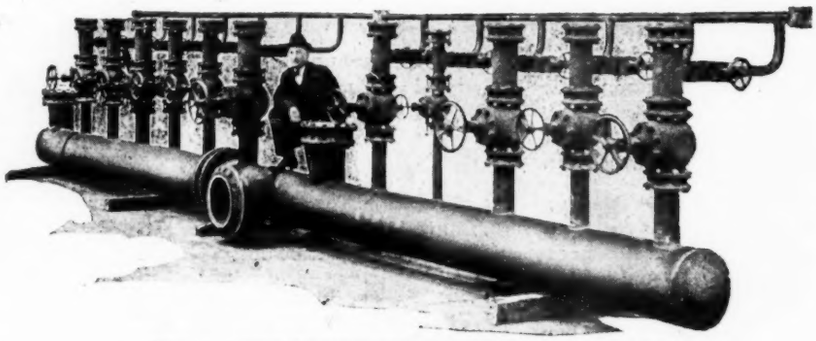


FIG. 1. THE STOCKHOUSE SUCTION GAS HEADER

losses, and the sum total of all losses was staggering, particularly so in such a large plant.

With all of the foregoing in mind, the writer took the problem under consideration, and after some careful study of conditions, designed and installed what is without question the largest, best-designed and constructed ammonia suction gas-main system ever erected.

Contracts for all the material were placed early in the summer of 1916, so that everything would be on hand to start work in the fall as soon as weather and load conditions would permit, as it was absolutely necessary that all these changes be made without interfering with the operation of the plant in any way.

The refrigerating plant consists of seven ammonia compressors ranging in size from 175 to 500 tons, totaling 2000 tons capacity. Two of these compressors were selected to handle the winter load and with some slight temporary suction-pipe connections, we were able to take care of any load conditions that might arise, while the old suction-pipe system was removed and the new mains installed.

The new 16-in. stockhouse header was first erected against a stockhouse wall directly opposite the engine room into which we were to connect the suction pipes from the various stockhouses, beer coolers, etc. There were eleven of these connections, varying in size from 3 in. to 10 in. Provisions were also made in the header leaving two 10-in. connections with blank flanges for any future connections that might be necessary. This header is shown in Figs. 1 and 2.

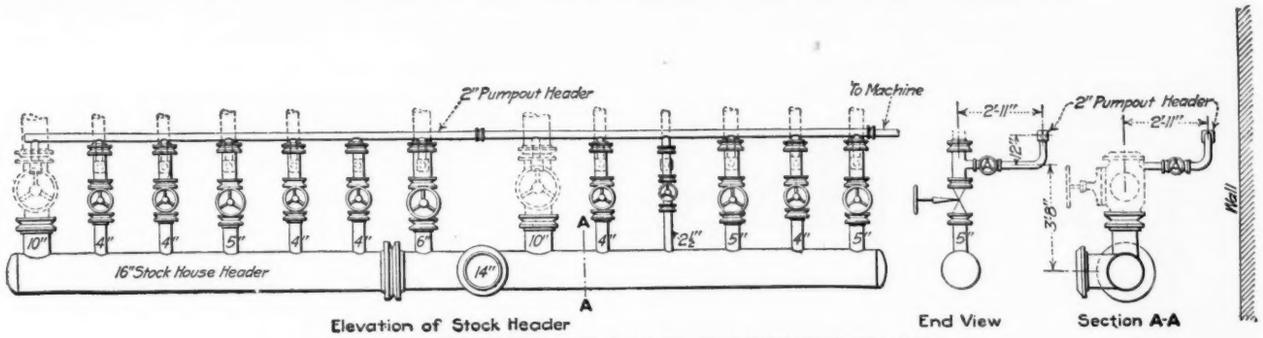


FIG. 2. ELEVATIONS OF THE 16-IN. STOCKHOUSE HEADER

This 16-in. header is 32 ft. long and all nipples are welded (oxyacetylene) with a 14-in. outlet to the engine room across the alley. This 14-in. main does away with a dozen or more separate suction-pipe lines that formerly crossed the alley at this point into the compressor room. Attention is directed to the 2-in. welded header just above the main stop valves, which is the pump-out header, which allows pumping out any stockhouse without interfering with any other.

All ammonia gas from stockhouses, cellars, beer coolers, etc., enters the 16-in. header, passes through the 14-in. main into the two 48-in. diameter by 10-ft. high

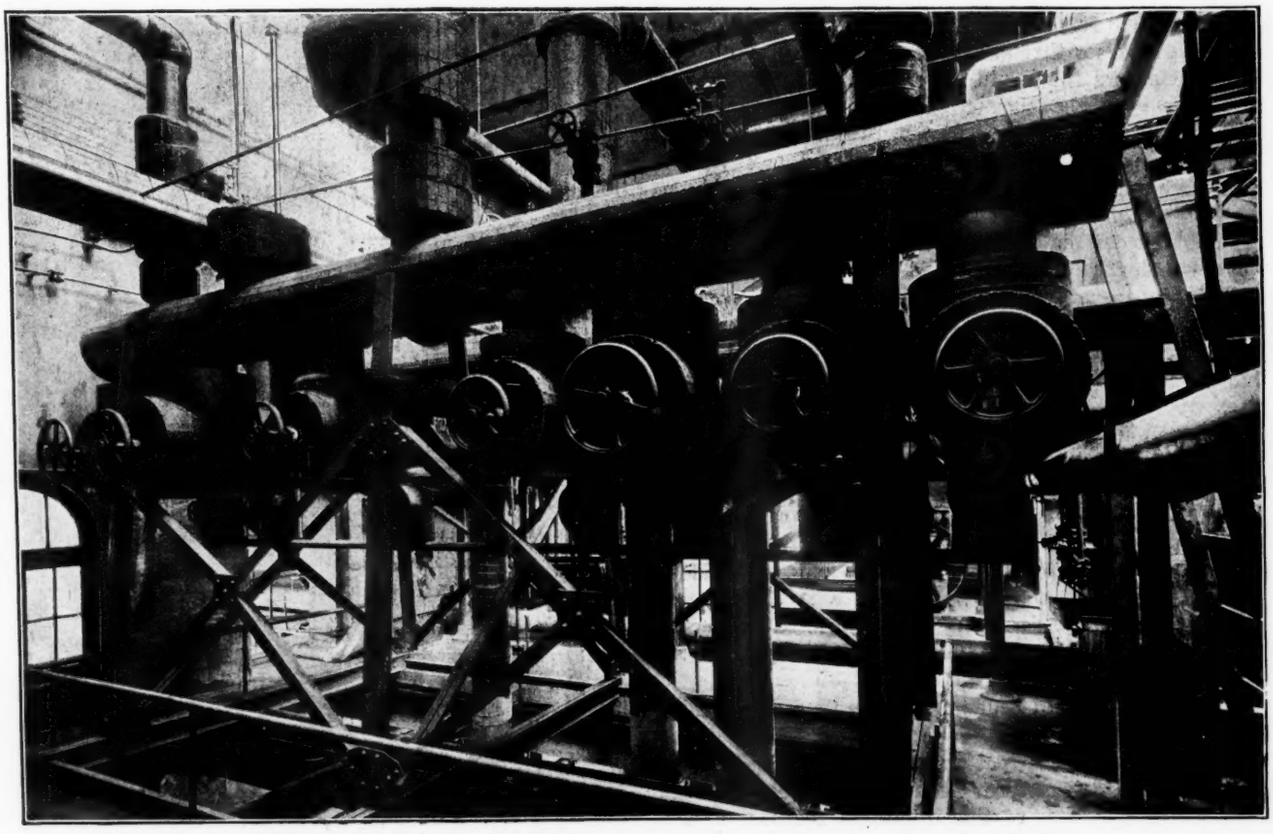


FIG. 3. THE SUCTION-GAS MACHINE HEADER IN PLACE AND PARTLY COVERED

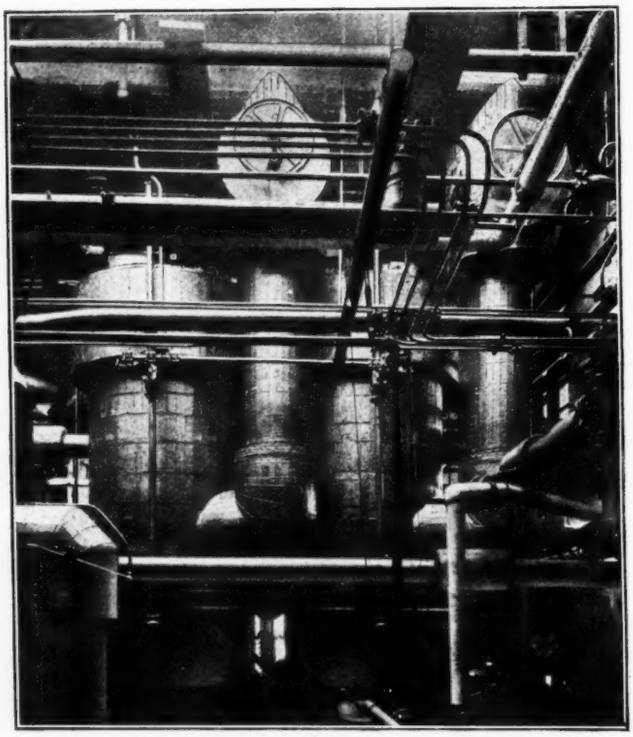


FIG. 4. THE 40-IN. BY 10-FT. LIQUID TRAPS

liquid traps located on the condenser floor above the compressors. These traps are all provided with welded 14-in. inlet and outlet connections and are also bypassed, in case it should be necessary, for any reason, to cut the traps out. (See Figs. 4, 5 and 13.)

These liquid traps are each provided with two concentric spiral coils made up of 2-in. extra-heavy pipe with a total of 1600 ft. of pipe. All liquid ammonia from the condensers passes through these coils, where it is cooled before it enters the liquid-storage tanks, by liquid carried over with the suction gas from the stockhouses and beer coolers. The traps are provided with liquid feed valves directly into the body of the traps, so in case there is not enough entrained liquid in the cold gas, the hot liquid from the condensers will heat the cold gas above a desired temperature; with this liquid feed valve, the degree of superheat is directly under the control of the operator. It has been found seldom necessary to use the liquid feed.

In case the cold gases carry more entrained liquid than the heat of liquid ammonia from the condensers can evaporate, this extra liquid is allowed to accumulate in the trap and is taken care of by two steam-driven liquid pumps of the ported suction type, which will absolutely pump anhydrous liquid ammonia, taking its suction at 15 to 30 lb., and discharging anhydrous liquid ammonia at 240 lb. Connected to the liquid traps are cylinders 20 in. in diameter and 28 in. long, all welded; each of these traps is provided with a steel float and stuffing-boxes. These floats are connected with the steam valve on the liquid pumps so that the pumps will start and stop with the level of the liquid.

All condenser-liquid headers into the traps are welded and bypassed.

The suction gas after passing through the liquid traps passes on to the compressor headers located on the same floor, which form one of the prominent features of the system.

The compressor headers are made up of a 12-in. and 14-in. wrought-iron pipe 20 ft., 4 in. long, all nipples welded in and cross-connected as shown, with angle valves and connections taken from the center of the cross-connections for the various machines on the floor below. (See Figs. 3, 8, 10 and 12.)

The 14-in. header takes care of all high-pressure suction gas from stockhouses, etc., also distilled-water coolers, and the 12-in. header provides for the low-pressure gas from the ice tanks and ice-storage and brine coolers, for which a separate main is provided. In this manner and with the headers cross-connected, any compressor can work on either high- or low-pressure gas according to the load conditions, and it also provides an independent suction-pipe system for the high- and low-pressure ammonia gas combined into one system of pipework.

The machine headers and the suction pipes to the various machines are all provided with 2-in. pump-out connections; in fact, there is a complete independent pump-out pipe system, which connects all different parts which go to make up the suction-pipe system, also all the high-pressure side, all connected to a small ammonia compressor installed expressly for the purpose of pumping out any compressor or any part of the entire system without interfering with any part of the plant. This has proved a valuable feature.

In making the suction-pipe connections from these headers to the compressors, the pipe sizes were all made

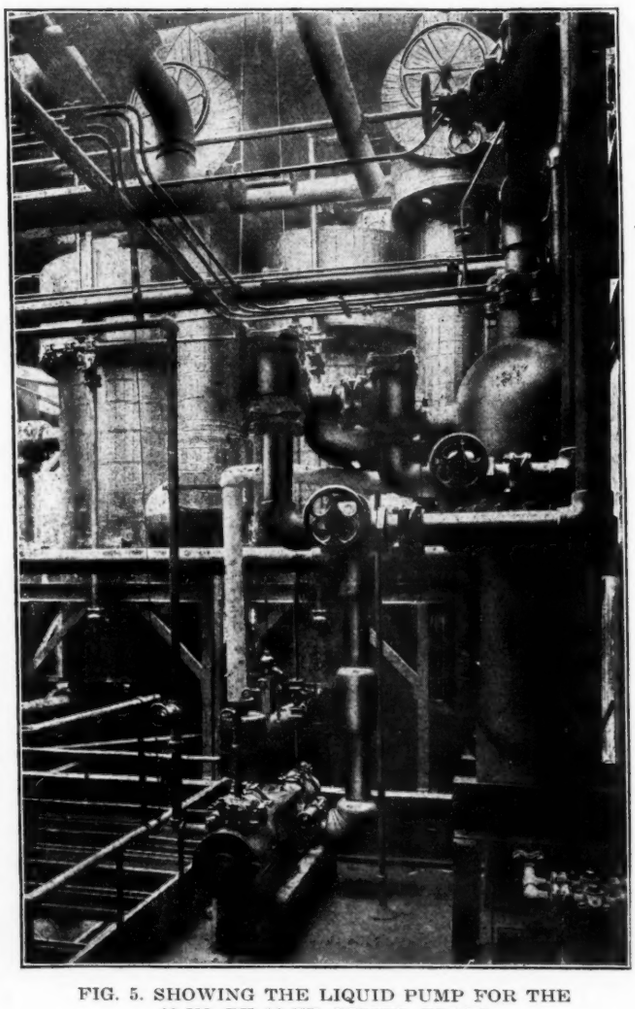


FIG. 5. SHOWING THE LIQUID PUMP FOR THE 40-IN. BY 10-FT. LIQUID TRAPS

considerably larger than the present machines called for; this provision was made because most of our compressors are of the older type with smaller suction pipes than are called for by the more modern compressors, and it is the intention, at some later date, to install more modern compressors calling for larger suction pipes, and by making this provision now, this suction-pipe system will not have to be changed to make the necessary provisions. In fact, the whole system of suction pipework was designed with a view of taking care of considerable more load at any future time.

The liquid-ammonia storage capacity was increased by the installing of three liquid-ammonia receivers, each 30 in. in diameter and 18 ft. long, all of the welded type, tested to 1000 lb. hydrostatic pressure. All connections into receivers are welded. Liquid inlet and outlet are all 4-in.; pump-out, drains, equalizers, etc., for all these receivers are connected together with welded headers.

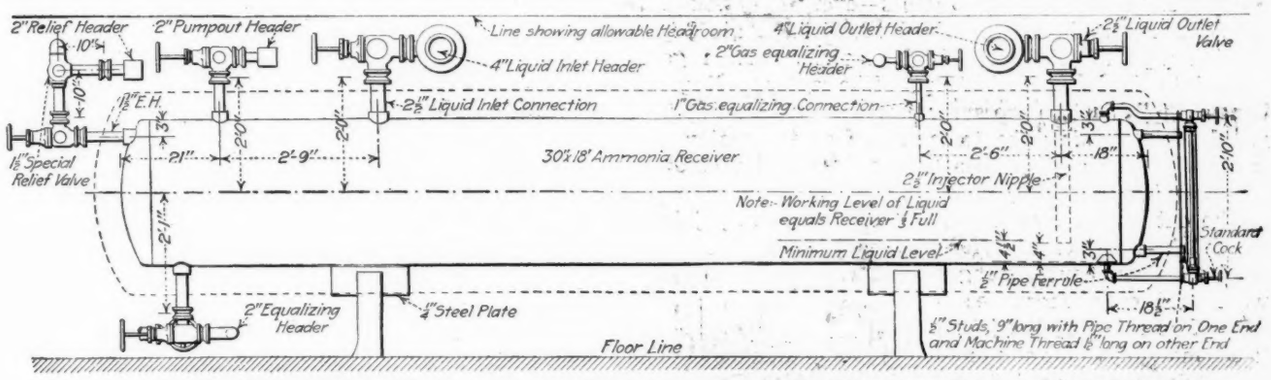


FIG. 6. ONE OF THE THREE 30-IN. BY 18-FT. WELDED AMMONIA RECEIVERS, SHOWING ALL CONNECTIONS

Each receiver is provided with a pop safety valve which discharges into a welded header and header piped to a large low-pressure suction pipe main (Figs. 6 and 11). Included with the suction gas-pipe system was the

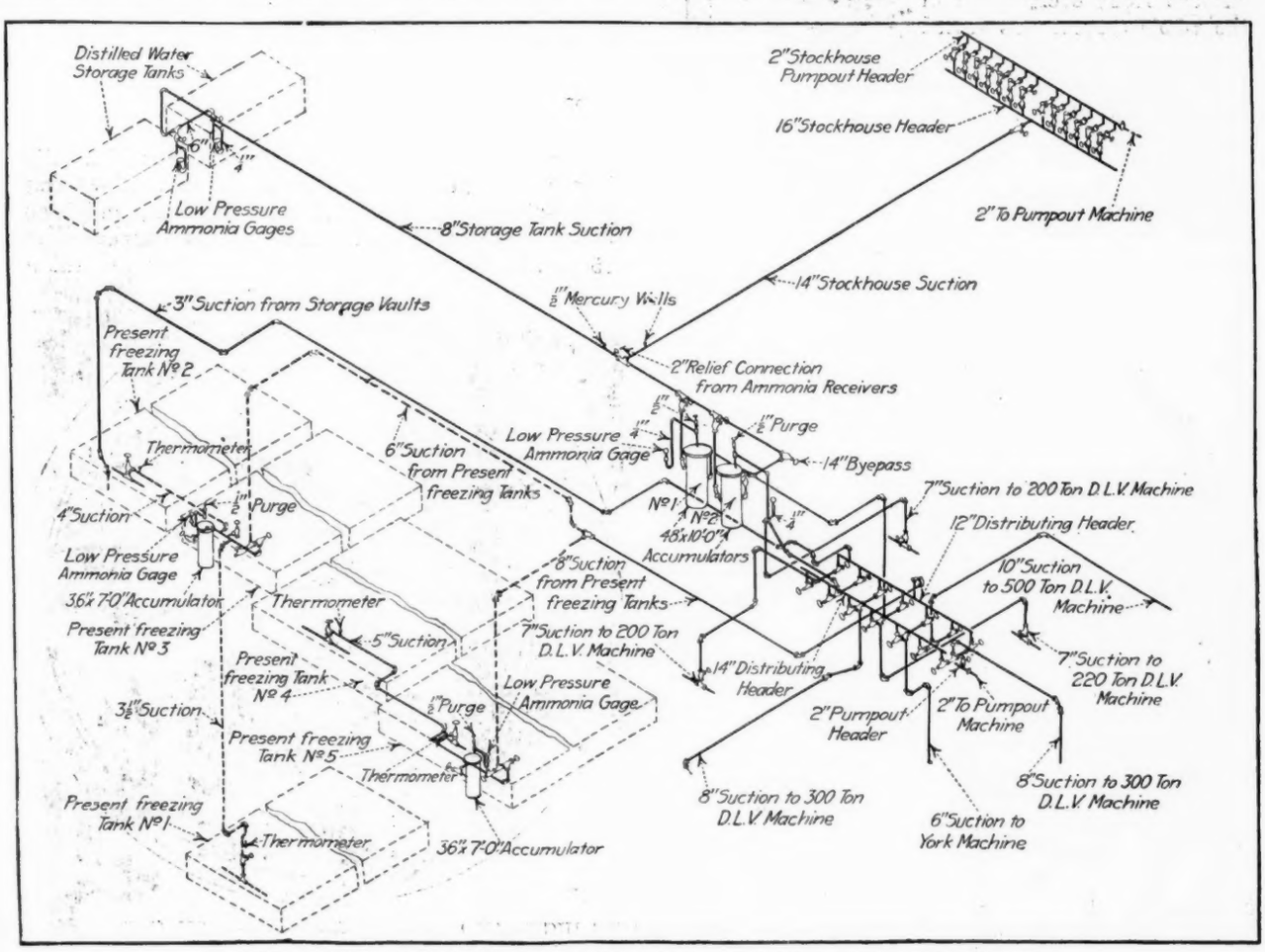


FIG. 7. SHOWING ISOMETRIC LAYOUT OF THE COMPLETE PIPING SYSTEM

changing of the five ice-freezing tanks from horizontal coils to vertical coils and installing two vertical motor-driven agitators for each tank, which made a great improvement on brine circulation. All liquid and suction headers were welded and placed inside the brine tanks.

For cooling the water before entering the ice cans, there were installed two water coolers, direct-expansion type, having a capacity of 200 tons daily. Each tank contains 800 ft. of 2-in. extra-heavy pipe made up in hairpin-coil shape, having no joints—everything welded; these cooling tanks are provided with a separate 8-in. suction pipe direct to the high-pressure suction gas main into the large liquid traps. The water cooling is done at 30 lb. suction pressure; recording gages are provided for obtaining the temperature of the water in and out of the coolers, also temperature and pressure of ammonia gas leaving coolers.

The entire work, all pipes, headers, etc., every joint possible, was oxyacetylene welded throughout; flanges were used only where necessary, thus reducing the joints to a minimum, which of course keeps down the liability of trouble and leakage. See Fig. 7.

All pipe is of wrought iron, and valves, fittings, flanges, etc., are of cast steel or air-furnace iron; every piece in the whole system was tested to 500 lb. pressure under water and guaranteed for a safe working pressure of that amount.

The entire system is equipped with instruments of the recording type. Each header has a recording pressure gage, also a recording thermometer; all liquid lines in and out of the traps are equipped with indicating thermometers, also the gas mains in and out of the traps. So complete is the equipment of instruments that conditions in any part of the system are known at all times and not only indicated, but recorded, so daily logs can be kept. Provision was made at various points throughout the system for mercury-column connections, so all pressure gages could be checked and kept accurate, as this is considered important.

The whole system is cork insulated, the various services having different thicknesses of insulation. All mains, pipe, fittings, valves, etc., have a 3-in. cork covering, while the liquid traps, accumulators, etc., are covered with 6-in. cork lagging. It might be well to call particular attention to the importance of insulating. In calculating the total surface of all mains, pipes, traps, water-storage tanks, liquid receivers, etc., and basing all calculations on an average outside temperature of 75 deg. F., the total B.t.u. loss per 24 hours of the uncovered surface amounts to 17,766,623 B.t.u. This same surface insulated shows a loss of only 1,510,052 B.t.u. and the saving effected is 16,256,571 B.t.u. per 24 hours, equal to $\frac{16,256,571}{287,000} = 56$ tons refrigeration saved per 24 hours.

The work was finished in June, 1917, and has been in

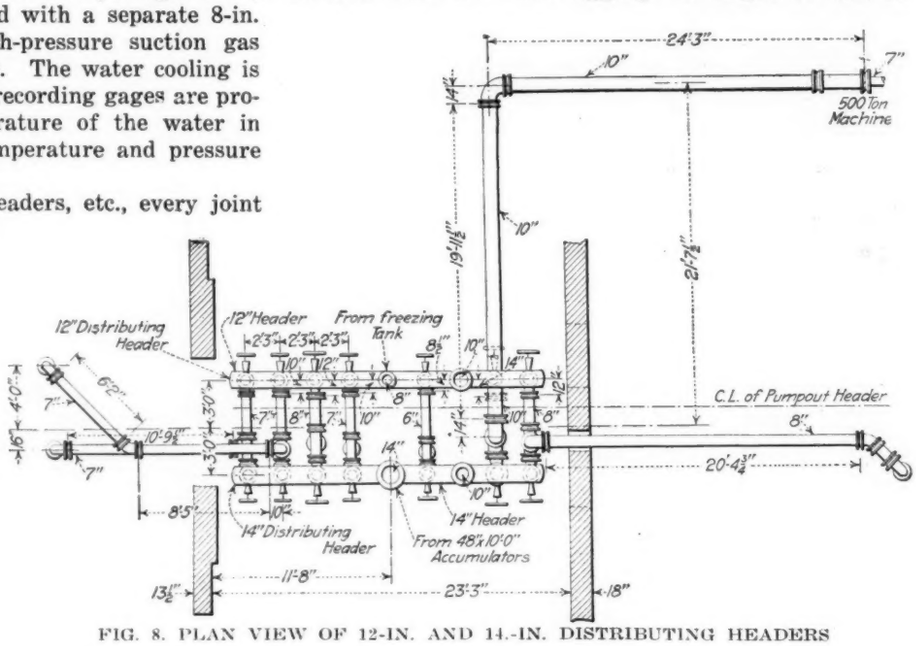


FIG. 8. PLAN VIEW OF 12-IN. AND 14-IN. DISTRIBUTING HEADERS

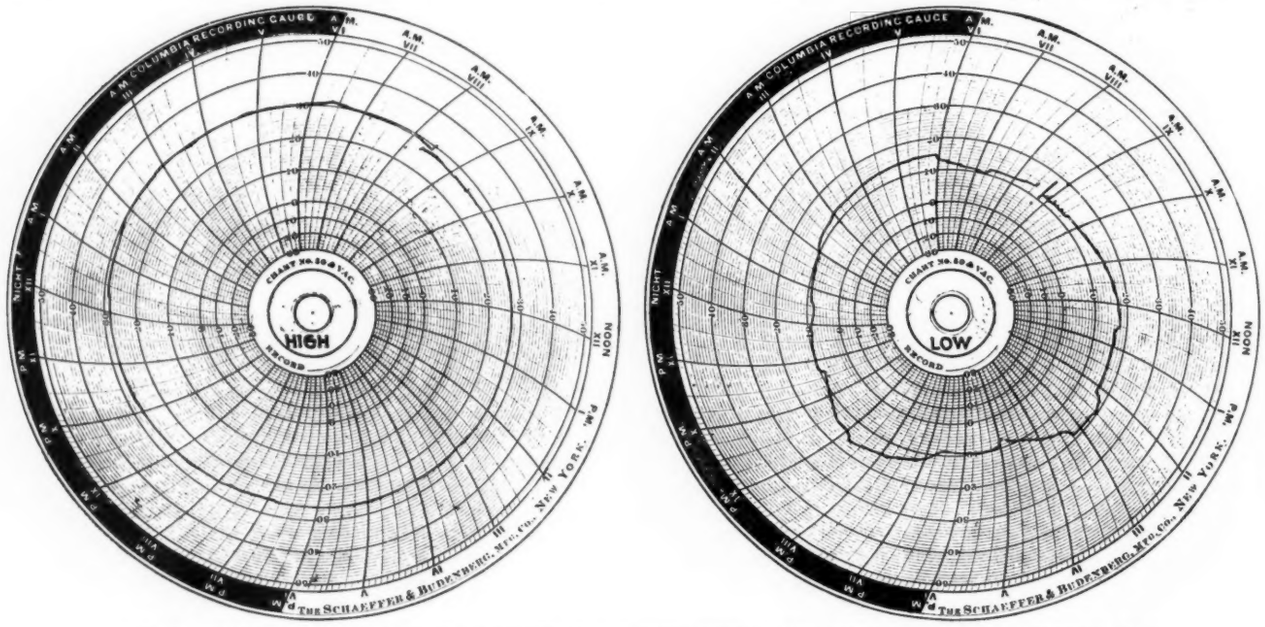


FIG. 9. CHARTS SHOWING THE PRESSURES OF THE HIGH- AND LOW-PRESSURE SUCTION GAS

highly satisfactory operation since, accomplishing all that was hoped for. Charts from the recording gages, herewith shown, graphically illustrate the two ammonia suction pressures carried at this point. See Fig. 9.

Briefly, the economy gained in making the changes as outlined in this article were that the low-temperature and high-temperature suction gases were completely isolated from each other and the high-temperature work

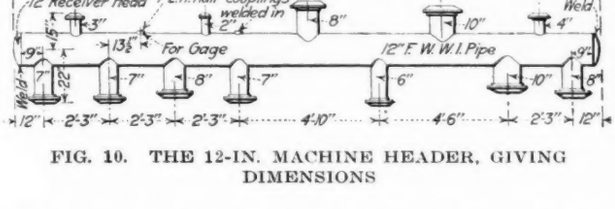


FIG. 10. THE 12-IN. MACHINE HEADER, GIVING DIMENSIONS

was done with high suction pressure and temperature, which was impossible in the old system of suction gas mains. The velocity of the gases in the mains was reduced to under 4000 ft. per min. as compared to 9000 and 12,000 ft., the velocity in the old mains.

The size of the main from the stockhouses (14 in.) was decided on and based on the maximum load conditions of 1000 tons refrigeration daily, 28 lb. suction and 200 lb. condenser pressure, which gives a velocity of gas

compressor cylinders, instead of a drop from 5 to 8 lb. that existed in the old system of mains; the economy of this is self-evident.

It wholly corrected the former trouble of liquid enter-

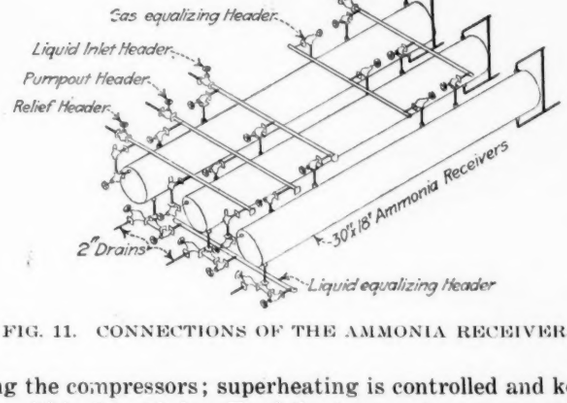


FIG. 11. CONNECTIONS OF THE AMMONIA RECEIVERS

ing the compressors; superheating is controlled and kept to within 5 to 10 deg. F. of the temperature corresponding to the suction pressure, and it is hardly ever necessary to use liquid injection in the liquid traps to keep it down, as we get just about enough entrained liquid with the return gases to obtain the desired results.

Installing the large liquid traps, which also cooled the liquid ammonia from the condenser temperature to an

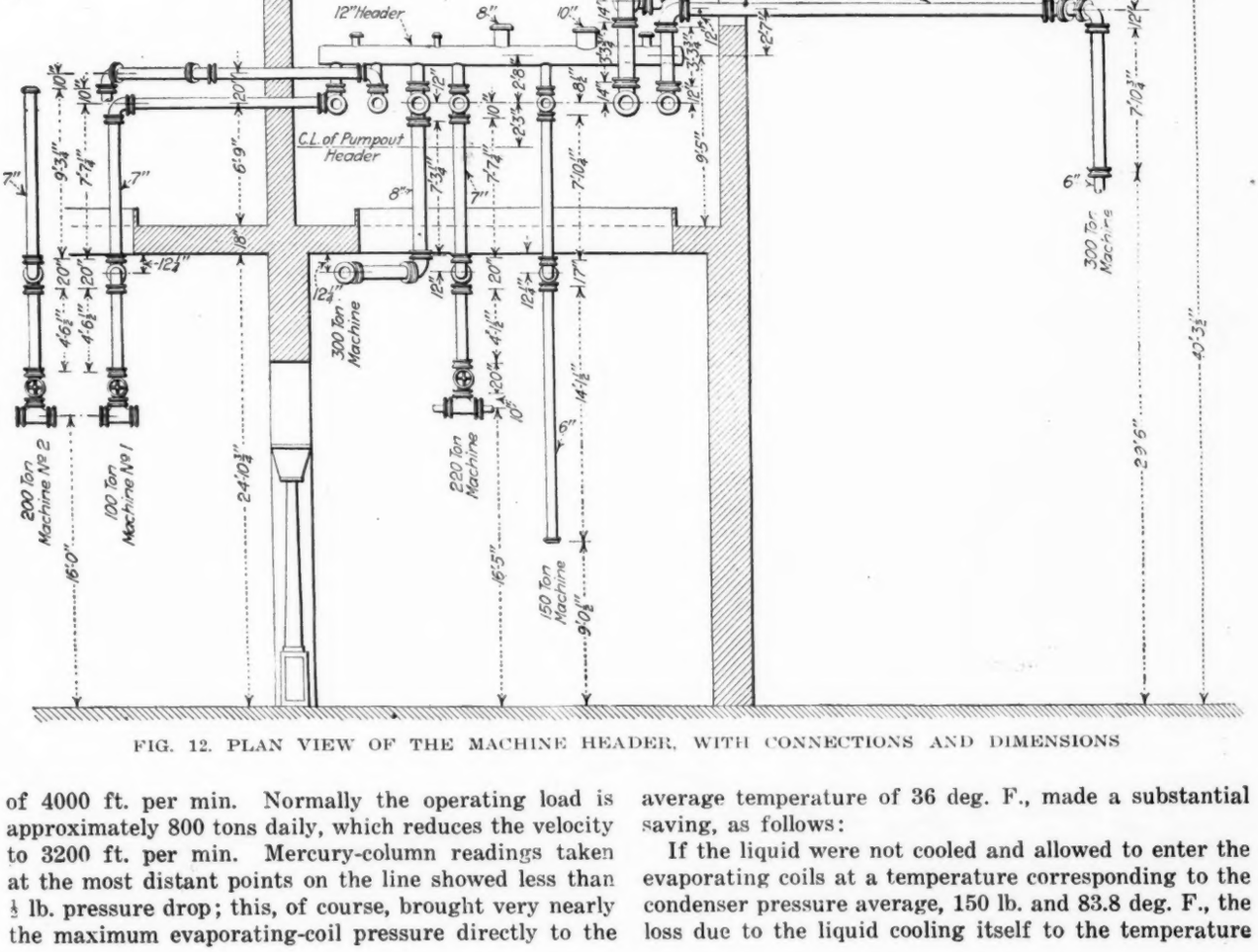


FIG. 12. PLAN VIEW OF THE MACHINE HEADER, WITH CONNECTIONS AND DIMENSIONS

of 4000 ft. per min. Normally the operating load is approximately 800 tons daily, which reduces the velocity to 3200 ft. per min. Mercury-column readings taken at the most distant points on the line showed less than ½ lb. pressure drop; this, of course, brought very nearly the maximum evaporating-coil pressure directly to the average temperature of 36 deg. F., made a substantial saving, as follows:

If the liquid were not cooled and allowed to enter the evaporating coils at a temperature corresponding to the condenser pressure average, 150 lb. and 83.8 deg. F., the loss due to the liquid cooling itself to the temperature

existing in the evaporating coils, before it could do any work, at 28 lb. and 15 deg. F., would amount to 13.5 per cent. The liquid-cooling traps cool the liquid to an average temperature of 36 deg. before entering the evaporating coils, therefore the liquid has only to cool itself from 36 deg. to 15 deg. in the evaporating coils, which causes a loss of but 4.18 per cent.

Looking at it another way, in the first case the compressor has to handle 3.6 cu.ft. of gas per ton per minute (assuming compressor efficiency 75 per cent) and in the second case only 3.26 cu.ft.; therefore $\frac{3.26}{3.6} \times 100$ equals 9 per cent., more work can be done by cooling the liquid from 83.8 deg. to 36 deg. before entering the evaporating coils, and for a plant doing 1000 tons of work this amounts to 90 tons per day.

The rearrangement of the ice-tank coils, together with the suction-gas mains resulted in increasing the ice-making capacity from 150 to 200 tons, or an increase

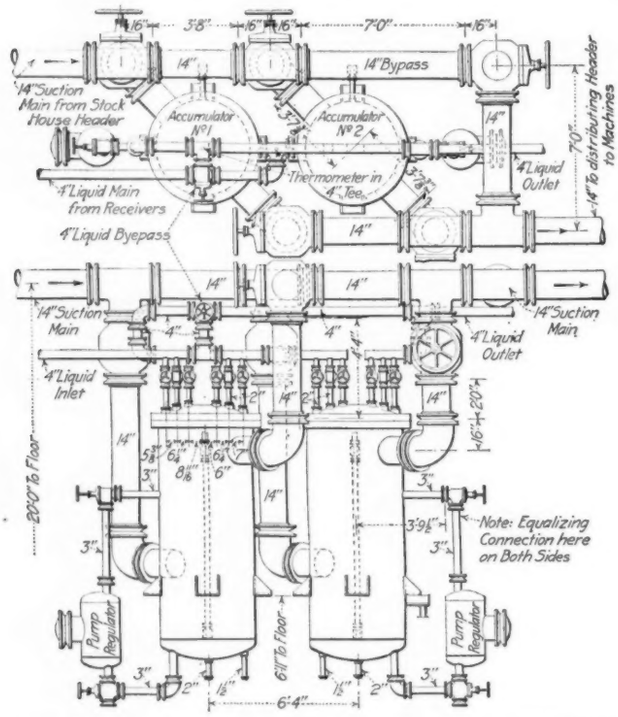


FIG. 13. THE LIQUID TRAPS, SHOWING ALL CONNECTIONS

of 50 tons of ice daily without adding any more evaporating coils or cans.

Changing the operating conditions of the stockhouses' load from 15 lb. suction and 150 lb. condenser pressure (150 lb. being the average condenser pressure yearly), which required 1.61 engine horsepower, to 28 lb. suction and 150 lb. condenser, which requires only 1.17 engine horsepower, and figuring on an average load of 200,000 tons yearly of refrigerating work from the stockhouses, it means a saving of 2,112,000 hp.-hr., equivalent to 3168 tons of coal yearly.

It also resulted in taking care of an increased load, using two less compressors than formerly, besides greatly improving the economical operation of the compressors that now carry the load and doing away with some engine-room labor.

From a financial point of view the economical returns are such that the installation will easily pay for itself inside of three years.

Sullivan "Wafer" Air-Compressor Valves

Single-stage, belt-driven and steam-driven compressors of relatively small size are now being supplied with the new improved plate valves developed by the Sullivan Machinery Co.'s engineers at the Claremont, New Hampshire Works. This valve, known as the "Wafer," is shown in the accompanying illustrations. It seats in a cage arranged radially to the axis of the cylinder and close to the two ends of the cylinder;

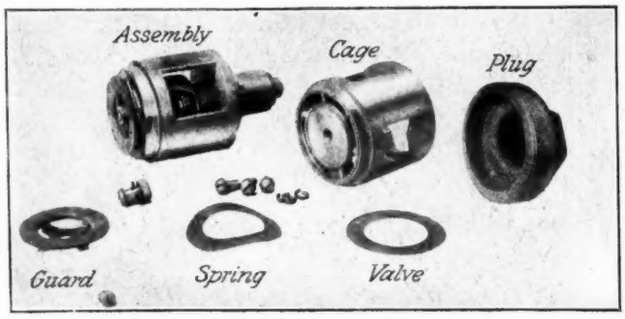


FIG. 1. "WAFER" INLET VALVE

the inlet valve is situated at the bottom and the discharge valve at the top. These valves are held to their seats by flat annular steel springs. They open against guard plates designed to give a wide port opening with a minimum of clearance volume, without restricting the admission or discharge of the air to or from the cylinder. The valve, spring and guard are accessible by the removal of a screw plug. Owing to the simple and short construction of the springs, the valves can be located close to the bore of the cylinder to keep down clearance losses.

Compressors equipped with these valves are unloaded in essentially the same manner as those equipped with automatic poppet valves. There is an air-pipe connection from the receiver, controlled by a pilot valve at the side of the air cylinder. When the receiver pressure rises to the unloading limit, the pilot valve admits air pressure through branch pipes to small

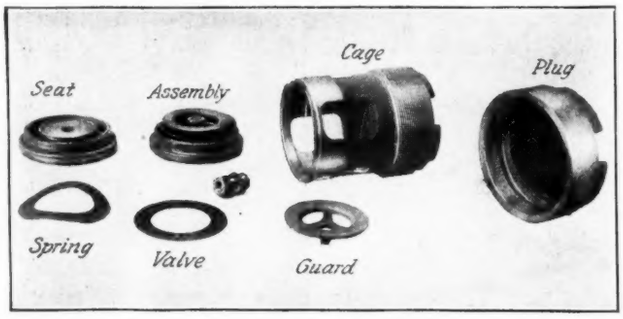
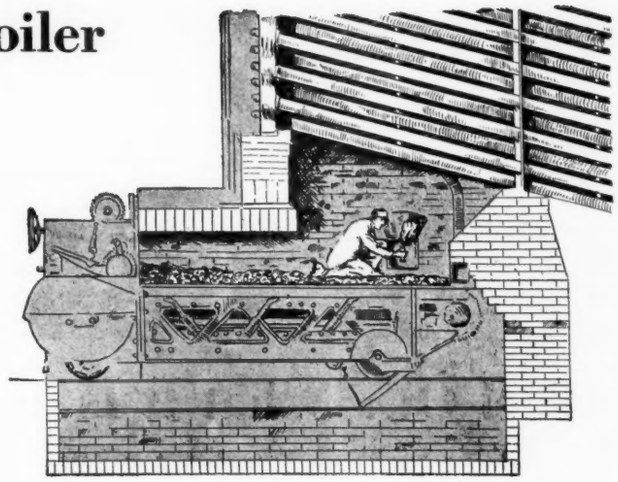


FIG. 2 VARIOUS PARTS OF "WAFER" DISCHARGE VALVE

plunger pistons in the valve plugs. The other end of the piston carries a three-pronged extension which raises the inlet valve from its seat until the receiver pressure falls the required amount, upon which the plunger piston falls, the valve seats and the compressor resumes its operation. While the valve is raised and the unloader is in action, no air is compressed, the piston of the compressor simply carrying the air at atmospheric pressure through the cylinder and open valves.

Final Inspection of Boiler Plants

By D. G. WALLACE



This article presents a method of determining the presence of air leaks into a boiler furnace that differs from that generally employed. It is used in the final inspection of the boiler after repairs or other work has been completed and before the boiler furnace is fired up.

CONDITION of boilers and settings at the time they are put under load governs to a great extent their efficient operation. Inspection is often neglected, and boilers are assumed to be in good condition for a run when the cleaners have finished their work. This is poor operating because if a boiler is not in first-class condition when starting a run, it is next to impossible to get the best results later.

In one plant I have in mind the boilers get a general external inspection before being cut off the line for the purpose of cleaning and repairs and a further inspection when cool enough to enter, so that repairs can be made in an intelligent manner. When a boiler is thoroughly cleaned and repaired, the chief engineer makes the final inspection and fills out the report-sheet shown herewith. Under "Remarks," all extensive repairs or unusual conditions are noted, and this report is then placed on file for reference.

Before a boiler is fired, the following test is made for air leaks, the furnace being equipped with chain-grate stokers, although the plan would apply to other kinds. The height of the hopper gate is noted for a check on the final coal-bed thickness and coal is fed in until the grate is covered to the water-back. The coal thickness is then measured at a number of points over the grate to determine if the proper distribution has been made. The thickness of the fuel bed will be from one-half inch to one inch less than the gate opening. This is partly due to the friction of the gate and to the lack of sufficient pressure in the coal hopper. It is common practice to speak of the fire thickness as being the gate opening, which is an error. When the coal thickness has been properly checked the inspector goes inside the furnace with a torch, all furnace doors being closed, and the boiler damper is opened until the draft gage shows the regular running conditions. The inspector then tests for air leaks, which are indicated by a violent blowing of the flame of a torch. A person making this test for the first time will be surprised at the inrush of air to the furnace even in settings that are in good condition and considered tight. Of course most of the leaks are around the doors and other openings.

Air leaks that would be impossible to locate from outside the setting will be discovered in this manner. This test will also show whether the grate and wall baffles are tight and are or are not allowing an excess of air to pass into the furnace from the ashpit, between the waterback and the grate.

All other parts of the boiler are tested in a similar manner under a draft corresponding to operating conditions. With an air inspection and test of this kind a boiler should go into service in first-class condition and a high efficiency may be expected.

Boiler No..... Date.....

	Mechanical Condition	Safety	Notation
Boiler tubes			
Waterback			
Water trough			
Boiler shells			
Man heads			
Water-feed pipe			
Water column			
Column pipes			
Safety valves			
Blowoff valves			
Stop and check valves			
Stop valves			
Boiler and heater piping			
Steam gage			
Brick setting			
Baffles			
Damper and equipment			
Blowout doors			
Peep holes			
Chain grates			
Gate drive section			
Furnace gates tight			
Ashpit			
Ashpit doors			
Fine coal chutes			
Ash chutes			

Remarks.....

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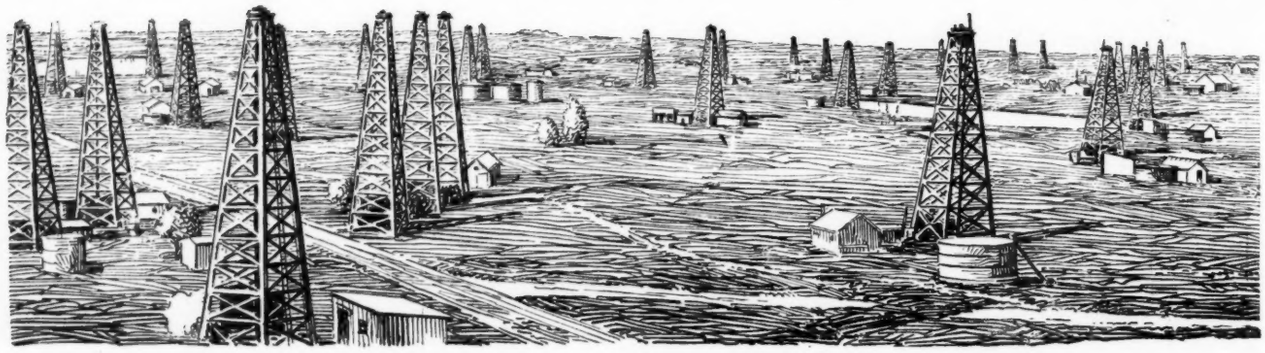
Chief Engineer.

The prospects of a good supply of oil fuel for Egypt are very promising. At the beginning of the war the Anglo-Egyptian Oilfields was the only one of the various companies formed to search for oil in Egypt that remained in operation, and down to 1914 the only finds of importance had been at Gemsah, where none of the gushers that had been struck had given anything like a permanent yield. But the new field discovered in 1914 at Hurgada has been proved to be of singularly regular formation, and its yield has steadily increased, until according to recent reports, it now stands at over 15,000 tons of crude oil a month. Meanwhile the Suez refinery has been enlarged, and there is every reason to hope that as much oil will shortly be available for internal consumption as can be dealt with by the company's existing facilities. It is stated that, in consequence, most of the public utility companies in Egypt have now converted their plants to burn petroleum residue.



Fuel Oil: What It Is and Where It Comes From

By RUFUS T. STROHM

SIXTY years ago this summer a man at Oil Creek in northwestern Pennsylvania started to drill a hole in the ground at a spot where he had observed oil oozing to the surface. At the end of three months of hard and discouraging work he struck oil, the flow of the well being over eight hundred gallons a day. That man was Col. E. L. Drake, and his achievement formed the beginning of a mighty industry that has encircled the globe, made the motor car and the airplane possible and ushered in what may be called the age of petroleum.

Nobody knows how petroleum was formed, but there are a number of theories to account for its origin. The one that is most generally upheld is the organic theory, which explains that the oil is derived from animal or vegetable material, or perhaps both, that was buried and acted upon by heat and pressure until oil was distilled from it. Crude oil, or petroleum, is simply a mixture of various hydrocarbons, or compounds of hydrogen and carbon, and the original hydrogen and carbon were contained in the animal and vegetable matter that was buried in the earth.

Of course such a process would be slow and would require ages of time. But a study of the layers or strata of rock and clay that form the crust of the earth shows that at one time land and sea plants grew in great profusion and that such animals as fish, mollusks and corals were very plentiful. The earth was subject to violent upheavals and sinkings in those early ages, and vast areas covered with plants were flooded by the sea. Similarly, bays and arms of the sea were closed into lakes by the rising of the ground.

Mud and silt, carried by streams, flowed into these lakes and into the sea and buried the plants and much of the animal life. Over the layers of mud and silt other layers of materials like rock, clay and sand were deposited as time went on. The pressure due to these thick layers of earth became enormous and produced heat, while the water that lay above the layers prevented the animals and plants from decaying, as they would do in the open air. The result of the heat and the great pressure on the buried vegetable and animal matter was to distill or drive off gases that later condensed into liquid form, and this liquid is what we call petroleum. Such is the organic theory of the origin of crude oil.

Now, petroleum does not occur in great underground lakes or pools. It is found in beds or layers of sand or porous rock, which it saturates in the same way as water saturates a sponge. Moreover, these oil-bearing sands are between layers of rock or clay through which the oil cannot flow, even under the great pressures that exist. The operation of obtaining the oil, therefore, is to drill a hole down through the overlying layers of earth and rock into the saturated oil sands. An opening is thus formed through which the oil can escape to the surface, aided by the pressure.

In proof of the statement that petroleum was formed from vegetable and animal substances it may be mentioned that the remains of such materials have been found in some of the oil-bearing regions. For example, oil wells in the Spindle Top District, in Texas, have been drilled through thick layers of vegetable matter containing tree trunks. In one of the oil fields of Russia the petroleum is found in strata in which the remains of fish are abundant. In most cases, however, the materials from which the oil is formed have been so completely decomposed and changed that no trace of them in their original state remains.

The common method of drilling is by means of a string of tools attached to a cable and given an up-and-down motion by a walking beam driven by a steam engine. The tool at the bottom of the string is the drilling bit, from 4½ to 6 ft. long, with a cutting edge that may have any one of a number of different forms. Above it and screwed into it is the auger stem, which is from 16 to 48 ft. long, and above that are the jars, which resemble two long chain links.

At the beginning the jars are not used, as the ground is fairly soft and the drill has no difficulty in penetrating. The weight of the string of tools is from 1½ to 2 tons, which is lifted by the walking beam and allowed to fall by gravity. The drill simply punches

its way downward through the softer earth and pulverizes any rock that it strikes. After the hole has reached a depth of from 100 to 200 ft., the jars are screwed into the string. Their purpose is to jar the drill loose when drilling in rock in which the bit is liable to stick. The sudden blow delivered by pulling up the upper jar until it strikes the lower one will loosen the drill bit when a steady pull on the rope would fail to move it. The jars are not used to drive the drill deeper on the down stroke. If the rope is too long, the upper jar will strike the bottom of the slot in the lower one, but this is accidental and will eventually damage the jars.

The auger stem gives increased weight and force to the blow of the drill; also, on account of its length, it aids the drill in cutting a straight hole. Above the jars the sinker bar is attached. Its purpose, also, is to keep the hole straight, and when drilling a hole that is partly filled with water it helps to sink the cable more rapidly. It may be placed between the jars and the drill bit so that it may add force to the blows. To keep out water and to prevent the sides of the hole from caving in on the tools, a casing or lining of iron pipe is put down. It is made of threaded sections that are screwed together, new sections being added at the top at intervals, as the depth of the well increases. Above the well is erected the derrick, a tapering framework of wood or steel towering eighty feet or more in the air and enabling the tools or the casing to be withdrawn readily when necessary.

If the well is put down in soft earth that tends to flow or cave badly, the rotary method of drilling is used. In this system the casing itself forms part of the drilling equipment. A steel cutting bit is screwed on the bottom end of the casing, which is given a rotary motion, with the result that it bores its way down through the ground. A mixture of water and clay is forced down inside the casing in a steady stream while drilling proceeds, and this mud flows out at the bottom and up to the surface around the casing, carrying with it the drill cuttings and at the same time tending to float the casing, thus making it easy to turn in the hole.

The depth of the well may be a few hundred feet or several thousand feet, depending on its location. This will be understood by reference to Fig. 1, which shows a vertical section through the crust of the earth in a typical oil field. The oil-bearing strata are not flat, but are tilted into folds or wrinkles and usually contain water in addition to oil. As the oil is lighter than the water, it floats on the top and so occupies the highest parts of the folds. If gas is present, it is found above the oil. Thus, if a well is drilled at *A*, it will strike gas and oil at a small depth; if it is drilled at *B*, it will have to go much deeper before oil is encountered; and if it is drilled at *C* it will strike no oil whatever. This will explain why some wells in a producing district fail to yield oil according to expectations.

When a well pierces the gas sand at the crest of a fold in the oil strata, there is likely to be a strong rush of gas at first, followed by the oil, which may spout to a height of a couple of hundred feet and may even carry away the derrick in the violence of its flow. A well that yields oil in this manner is called a gusher, and the quantity of oil discharged is sometimes enormous. For example, a well at Tuxpam, Mexico, several years ago flowed for some time at the rate of 160,000 bbl. a day.

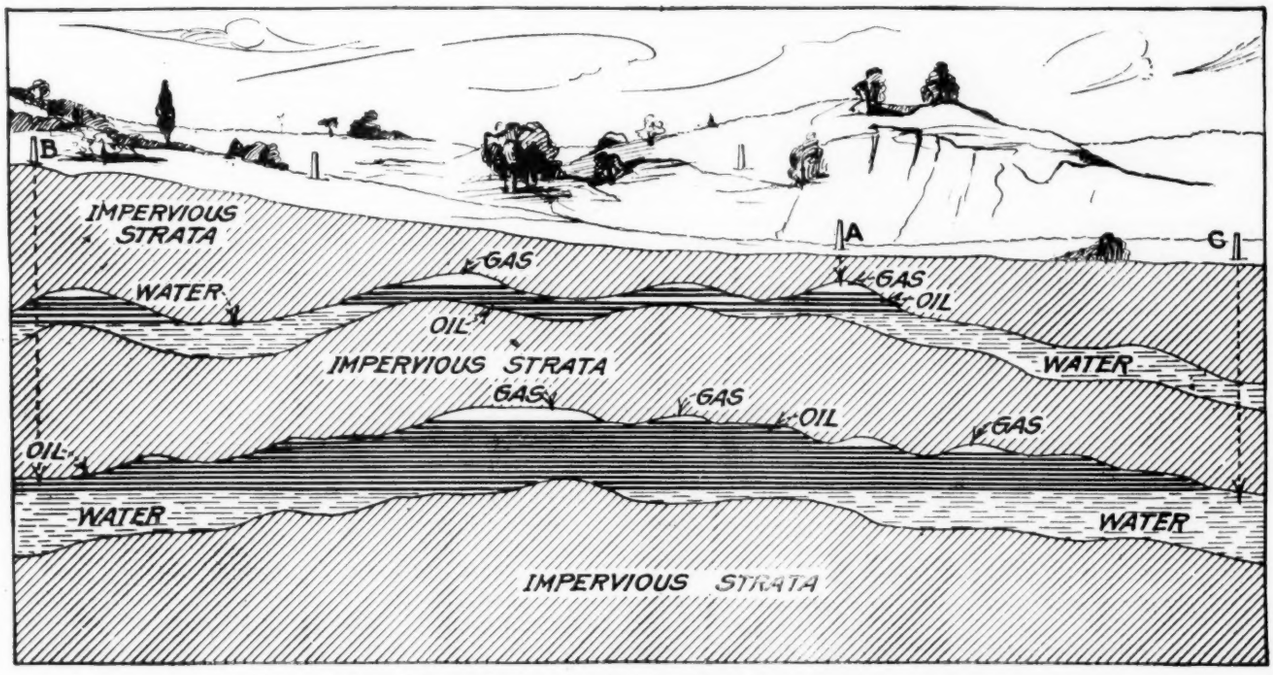


FIG. 1. VERTICAL SECTION OF CRUST OF EARTH IN TYPICAL OIL FIELD

Gushers are responsible for the loss of much oil. If the flow is greatly in excess of that expected and the available tanks for receiving it are inadequate, it is caught in hastily constructed earth dams. The result is loss through seepage of oil into the porous ground. An additional loss is involved by the evaporation of the lighter constituents of the oil and their escape into the atmosphere in the form of gases and vapors.

Accidental fires may cause great waste of oil. For example, a well being drilled in the region north of Tampico, on the Gulf of Mexico, struck oil on the Fourth of July, 1908. The drilling outfit was being operated by a steam engine, which was supplied from a nearby boiler.

The well gushed so rapidly that before the fire in the boiler could be put out, oil had reached it and had ignited. The result was that the spouting petroleum burned in a jet of flame a thousand feet high and sixty feet wide, making a glare that could be seen for a hundred miles. For two months the fire raged, consuming oil at the rate of 60,000 bbl. a day, and before it was put out it had caused a loss of more than $3,000,000.

Not all wells, however, flow in such a manner. Many of them contain so little gas that the oil must be raised by pumping. Even the gushers sooner or later decline in their production, and the accumulated experience of years makes it possible to predict with reasonable accuracy the output of the wells in a certain group. If the flow is sluggish at first, or if it has declined greatly, production may possibly be stimulated by shooting the well. This consists in exploding a charge of nitroglycerin at the bottom of the well.

A can containing several gallons of nitroglycerin and fitted with a detonating cap in its top is lowered to the bottom of the drill hole. Then a heavy piece of iron, known as a "go-devil," is dropped down upon it. The explosion that results shatters the strata at the bottom of the well and enlarges the opening around the foot of the well casing, thus enabling the oil to flow more readily.

The color of crude oil varies considerably according to the locality in which it is found as well as the manner in which light falls upon it. If viewed by transmitted light, as by looking through a sample of the oil, the color may be pale straw, yellow, red, brown, dark brown or black. In a few rare cases crude oils are colorless and are known as white oils.

When viewed by reflected light, crude oil shows a greenish florescence that is called "bloom." This can be removed by filtering the oil through fuller's earth. It is logically assumed, therefore, that the varieties of white oil found in scattered regions are simply darker oils that have filtered through the earth and have been deprived of their color in so doing.

TABLE OF BAUME READINGS AND EQUIVALENT SPECIFIC GRAVITIES

Baumé Reading	Specific Gravity	Baumé Reading	Specific Gravity	Baumé Reading	Specific Gravity
10	1.0000	27	0.8917	44	0.8046
11	0.9929	28	0.8861	45	0.8000
12	0.9859	29	0.8805	46	0.7955
13	0.9790	30	0.8750	47	0.7909
14	0.9722	31	0.8696	48	0.7865
15	0.9655	32	0.8642	49	0.7821
16	0.9589	33	0.8589	50	0.7777
17	0.9524	34	0.8537	51	0.7735
18	0.9459	35	0.8485	52	0.7692
19	0.9396	36	0.8433	53	0.7650
20	0.9333	37	0.8383	54	0.7609
21	0.9272	38	0.8333	55	0.7568
22	0.9211	39	0.8285	56	0.7527
23	0.9150	40	0.8235	57	0.7487
24	0.9091	41	0.8187	58	0.7447
25	0.9032	42	0.8139	59	0.7407
26	0.8974	43	0.8092	60	0.7368

The specific gravity of petroleum varies from about 0.74 to 1.0, the lower value applying to certain of the white oils already mentioned. Ordinarily, however, the specific gravity is between 0.84 and 0.94. Some of the black oils of Wyoming have a specific gravity of 0.966. If the crude petroleum is exposed to the air for some time, its specific gravity will increase, owing to the evaporation of some of the lighter constituents.

The oils from different regions have characteristic odors, and these are so well recognized that the source of an oil may often be determined by the odor. Pennsylvania crudes, for example, are characterized by a gasoline smell. An aromatic odor similar to that of coal-tar oils clings to California oils. But if the oil contains sulphur, it will have a decidedly disagreeable odor, particularly if the sulphur is present as hydrogen sulphide.

To avoid the use of decimals in expressing specific gravity, the Baumé system is used in the oil trade. The Baumé scale is purely arbitrary, the point marked 10 corresponding to a specific gravity of 1.0 and the remainder of the scale being graduated in degrees up to 60. A scale having this range can be used for oils having specific gravities from 0.737 to 1.0, as indicated in the table. It should be noted that an increase in the Baumé reading corresponds to a decrease in the actual specific gravity of the oil; in other words, the heavier the oil the smaller is the reading on the Baumé scale. The values given in the table are correct for a temperature of 60 deg. F.

The oil that flows from the well or that is pumped from it is collected in stock tanks, where it is allowed to stand for a time in order that the sand and dirt may settle out of it, after which it is pumped through pipe lines to refineries or to places of distribution. At the refinery it is subjected to the distillation process, which consists in heating the oil in closed tanks so as to cause some of it to pass off as vapor, the vapor being afterward condensed to liquid form by cooling.

The heating is done progressively; that is, it is begun gently and gradually increased in intensity. The reason

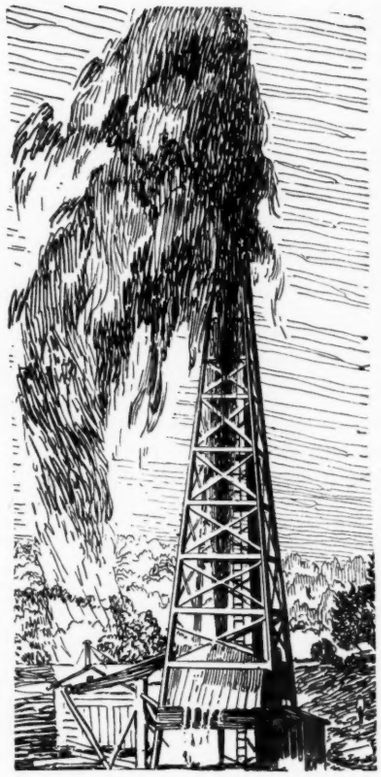
Per Capita Consumption of Petroleum in 1918, Based on a Population of 100,000,000
3.4 BBL.
Per Capita Production of Petroleum between 1859 and 1919 in the United States
45 BBL.
Estimated per Capita Reserve of Petroleum remaining Unexploited in the United States
67 BBL.

FIG. 2. DIAGRAM SHOWING OIL USED AND UNUSED IN UNITED STATES

is because crude oil is a mixture of a large number of oils that boil at different temperatures. The details of the distillation process vary in different refineries according to the nature of the crude oil, but the subsequent outline will serve to indicate, in a general way, the method of procedure.

The first vapors to be driven off under heating are those of the lightest and most easily vaporized constituents of the crude; namely, benzine, gasoline and naphtha. These have specific gravities higher than

about 52 deg. Baumé. Next the kerosene is distilled, this having a gravity of about 41 deg. Baumé. On further heating, solar oil or distillate oil is produced, which has a specific gravity of approximately 37 deg. Baumé and is used as fuel in oil engines. The next compound to be distilled is gas oil, which ranges from 24 to 26 deg. Baumé. The remainder of the oil in the still after the foregoing have been driven off is called residuum. It may be sold as fuel oil, for use in boiler furnaces or industrial heating, or it may be further distilled to produce lubricating oil, cylinder oil, paraffin and coke.



In a general way fuel may be defined as oil that is not marketable for some other special purpose at a price greater than that which the fuel oil will bring. Much of it is the residuum from the distillation process just described; but there is a considerable percentage composed of crude petroleum as it comes from the well, and still another large fraction is the residue from the skimming or topping process.

The topping process is simply a partial distillation of the crude oil, resulting in the recovery of gasoline and kerosene. The growing demand for these lighter oils in recent years makes their recovery not only profitable but imperative. The oil remaining after they have been driven off is very fluid. Most of the topping plants are west of the Mississippi, for the simple reason that the Eastern oils are too valuable to permit the loss of the lubricating oils and other products below the grade of residuum.

The extent to which fuel oil is used in the United States may be inferred from the fact that more than half of the total yearly consumption of petroleum is utilized as fuel for steam raising, this including not only the fuel oil produced by the refineries, but the oil used in its crude state as well. The whole southwestern part of the United States is dependent on oil fuel, because of the absence of near-by coal fields, and there has been a marked increase in the use of liquid fuel in the New England section because of industrial expansion brought about by war activities.

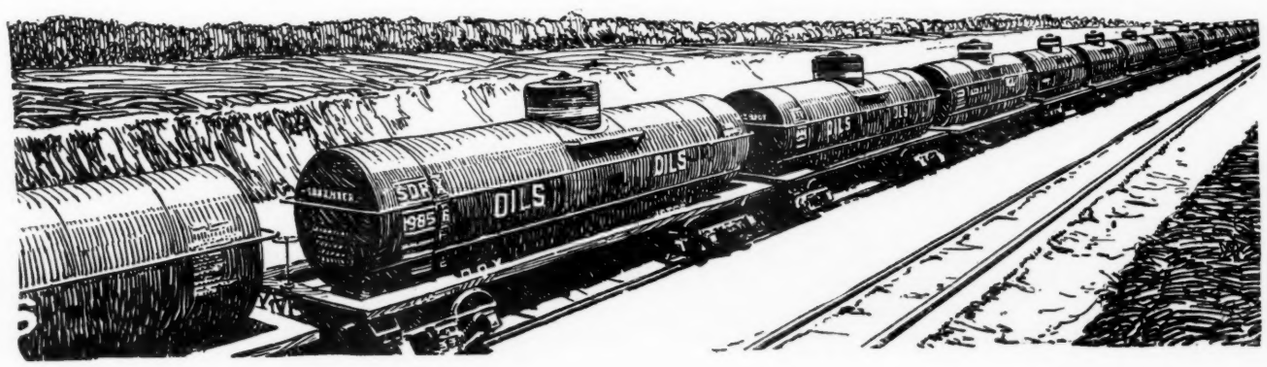
War demands placed an unprecedented burden on the oil industry, with the result that the rate of consumption greatly exceeded the rate of production, the difference being made up by importing oil and by drawing on the reserve stocks. During 1918, according to the statistics of the Geological Survey, the total marketed production of crude petroleum in the United States was 345,896,000 bbl. of 42 gal. each. In the same time the consumption amounted to 367,489,000 bbl., indicating that the domestic production fell behind the consumption by 21,593,000 barrels.

Because of the importance of fuel oil in the operation of steam boilers and the tendency toward its increased use in this respect, the matter of the available supply is of vital concern to the user. The Geological Survey has made estimates of the petroleum reserve in the United States as well as of the consumption since oil was discovered in 1859, and the figures are startling.

Assuming a population of 108,000,000, the consumption per person in the United States during 1918 was 3.4 bbl. The oil that has been produced since 1859 amounts to about 45 bbl. per person, and the oil yet underground, according to the most careful estimates, amounts to about 67 bbl. per person. These facts are shown graphically in Fig. 2. Now, if the population of the United States remained unchanged and the rate of consumption did not change, the oil available would last about 20 years. But the population is continually increasing and the demands for petroleum are multiplying, so that in less than 20 years the known domestic underground fields will be exhausted if the statistics are even approximately correct. Oil shales are not considered in this connection as a source of fuel oil.

This conclusion does not mean that fuel-oil users will be unable to obtain supplies, for the data apply only to the sources of petroleum within the United States. There are vast fields in Mexico and Russia, from which oil may be obtained, but of course at increased cost because of the transportation expense. Also, it is possible that additional oil deposits will be discovered as the older ones pass into decline.

Steam engineers in particular should be interested in the conservation of oil fuel, since they use more than half of the total production, indicating that approximately 200,000,000 bbl. of oil per year is utilized in steam generation. Taking into account the statement of the Bureau of Mines that 40,000,000 bbl. of fuel oil is wasted every year by inefficient and careless methods of firing, it may be seen that there is a wide field for the exercise of economy in the use of oil fuel.



Overload Protection for Electric Motors

By O. C. CALLOW

Briefly discusses the different types of overload protection for motors, which are in common use, showing their respective disadvantages and shortcomings and suggesting other and better arrangements to suit various conditions.

ELECTRICIANS and operating engineers are familiar with the fact that the fuse was the first type of overload protection used for electric motors and circuits. The fuse as an overload protection will give good results when used with motors that run with a steady load and occasional light overloads and where the starting duty is normal. Owing to the fact that a fuse has a certain time lag equal to the time required for it to heat up and blow, it can be used on small overloads of short duration without shutting down the motor and still give good protection.

These points should be borne in mind when making an installation, and if the conditions of the load differ from those mentioned, then a better form of protection should be sought, as described later.

Being simple in construction, easy to understand and of low initial cost, fuses are not infrequently used where a little investigation will show that they do not give sufficient protection to the equipment against overloads. Take, for instance, the case of a drive which requires a large starting peak, such as a hoist, and which is controlled by means of a drum controller. The fuses have to be of such a capacity to withstand the high peaks that they are of little protection against a steady overload and will blow only in the case of a short-circuit. Serious damage can therefore be done to the motor under the conditions without blowing the fuses.

A point that cannot be too strongly emphasized is that whenever fuses are used they should be installed in a safety box provided with a lock and key and kept locked, also arranged so that the circuit must be open before anyone can attempt to draw the fuses. The writer has seen many accidents caused by means of open-type fuses. With the old type of wire or strip fuse there is always the danger of fire or of the molten metal flying into the operator's face. With the cartridge fuse this is avoided. Of course, there is the danger of someone removing a fuse while the load is on, in which case he will most likely only partly open the circuit, and thus start a heavy arc.

A further objection to an open-type fuse is the ease with which it can be shunted by means of a piece of heavy wire, thus defeating the very purpose it was installed for. In many cases when a fuse blows there is no spare at hand or no fuse wire, with the result that any conveniently handy piece of wire which is heavy enough not to blow again is inserted with little thought to the reason which first caused the fuse to blow.

These are conditions which actually exist in many plants and can easily be found upon careful inspection. The inclosed safety switch and fuse eliminates many of them, but much time is often lost in finding the operator who carries the key of the boxes and getting the necessary fuses of the correct size. One manufacturer of these switch boxes has been thoughtful enough to provide a spare fuse mounted inside the box, which often makes a great saving in time.

It is a surprising thing that in many plants that use both alternating-current and direct-current motors, the direct-current equipment is well protected and a large amount of money has been spent on magnetic control, making a first-class installation. The alternating-current motors, however, have to depend upon fuses for protection, and these are not always connected as they should be—arranged so that the starting current does not pass through them. This is a very important point when a compensator is used. The fuses should be arranged in the running side only, otherwise they will have to be heavy enough to carry the starting current, which is about three to four times normal when starting against full load with a squirrel-cage induction motor. It can readily be seen that the fuses would be

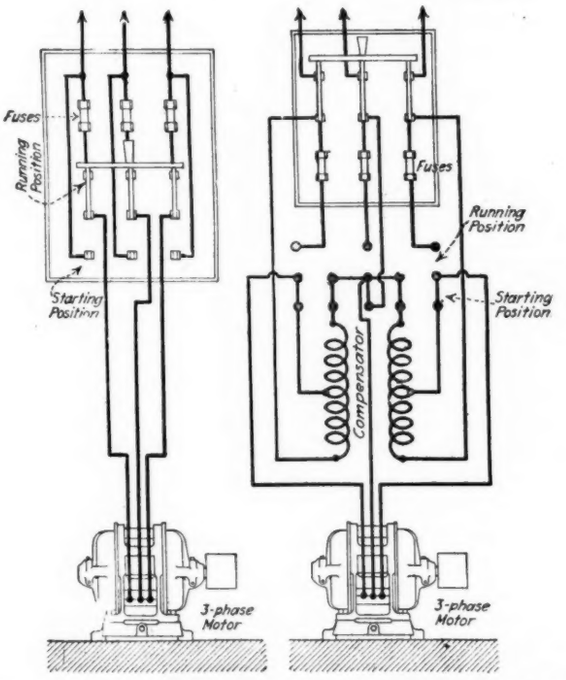


FIG. 1. MOTOR CONNECTED TO STARTING SWITCH

FIG. 2. MOTOR CONNECTED TO COMPENSATOR

worthless for overload protection in a case like this. The correct connection in this case would be as shown in Fig. 2. If the motors are small, below five horsepower, they can be started direct across the line, but a three-pole double-throw switch should be provided with the fuses connected in one side only, for the same reason as given (Fig. 1).

A great improvement has been made in the overload protection of motors by the introduction and large use of magnetic control panels. With this class of apparatus it is usual to install two overload relays, one connected in series with each side of the line, and arranged to

open-circuit the magnet coils of the line switches. These relays are calibrated for settings from 0.75 to 2.5 times full-load current and can be relied upon to open up the circuit when these values are reached. They are made either for hand or automatic resetting. With this arrangement the motor will be well protected and time saved in operation. Should a relay of this type open up the circuit in normal operation, with automatic

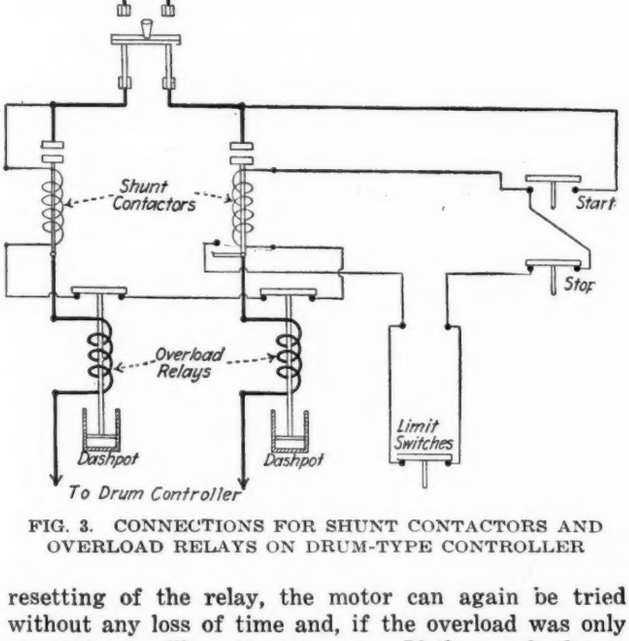


FIG. 3. CONNECTIONS FOR SHUNT CONTACTORS AND OVERLOAD RELAYS ON DRUM-TYPE CONTROLLER

resetting of the relay, the motor can again be tried without any loss of time and, if the overload was only momentary, will continue to run. If the overload continues, the relays will again trip, so that the motor cannot be started until the trouble is remedied. Furthermore, this type of protection does not lend itself to being tampered with to the same extent as fuses, and in the case of shutdown someone in authority is more likely to be notified.

Most of these types of relays are installed with an instantaneous trip, which is a great disadvantage when used on those drives where heavy peaks are encountered, as they have to be set at such a high rating that they lose much of their value as protection to the motors. This can be remedied to some extent by using inverse-time limits on the overload relays. These mostly take the form of an oil dashpot arranged to retard the action of the relay plunger and are provided with adjustments to suit different load conditions. With these attachments the relays will not trip on a sudden peak of short duration, which would be encountered in ordinary operation and which would not cause any trouble to the motors. They will, however, allow the relays to trip in the case of a continued overload and will give a fairly good protection to the motor.

One of the chief objections of the foregoing arrangement of relays is that they do not give much protection against a very heavy peak, owing to the fact that it is extremely difficult to design a dashpot that will both give the necessary retarding action and still open practically instantaneously on very severe conditions of heavy peaks. A good method of overcoming this trouble is to install two overload relays, one arranged with an instantaneous trip and the other with inverse-time limit. The latter type of relay should be set for ordinary operation, and protects the motor against steady overload and peaks up to a safe limit which would not harm the motor. The instantaneous-trip relay is then set to trip on any peak which it is decided is the limit that the motor would withstand with safety. As this is an instantaneous relay, it will open immediately the value is reached that it is set for, and shut down the motor. The addition of these relays can therefore be recommended for drives that handle heavy peaks and operate against large starting loads with quick reversals, such as steel-mill table drives and cranes.

The foregoing relays make a very good combination for use with drum controllers, particularly when made up into a panel with two magnetically operated shunt-line contactors. Complete protection is thus gained against overloads. A no-voltage relay can be connected, arranged so that the controller handle must be in the "off" position before the line switches can close, a very desirable arrangement in the case of failure of supply.

Limit switches can be connected in the control circuit to stop the motor at any given point, irrespective of the position of the controller; also, push-button stations can be provided to start or stop the machine from a distance in the case of trouble. A connection of this arrangement can be made as shown in Fig. 3. The addition of a good circuit-breaker is often warranted in connection with large motors to give complete protection. They should be built double-pole and should have overload and no-voltage trips and also time-limit device if the drive requires it. Circuit-breakers are now built that will stand a great deal of vibration without opening the circuit, and they can be used readily on cranes with good results. If a crane is equipped with drum controllers with fuses only for protection, circuit-breakers can be installed for each of the large motors. Full protection will thus be obtained and the life of the equipment very much lengthened. Time-limit devices should be arranged on the overload relays on the breakers and push-buttons can also be installed in connection with the no-voltage relay so that the breakers cannot be closed while men are working on the crane.

When a number of motors are located in one room, a very good arrangement can be made by installing a distribution switchboard containing a circuit-breaker for each motor, and thus no other protection is required. This can be carried out for either alternating or direct-current equipment. If the circuit is three-phase alternating-current, the breakers should be three-pole with two overload relays and time limits. For voltages higher than 440 alternating-current individual oil switches are to be recommended, equipped with the previously mentioned relays. Another good alternating-current installation can be made by placing a self-contained oil switch and compensator on each motor, or if the motors are of the slip-ring type, the control arrangement can be carried out with the rotor starters. The oil switches should have two overload and one no-voltage relays with time-limit attachments, so that they will not trip out during the starting period, which takes a large current during this time

The addition of an inexpensive ammeter mounted in view of the operator is often a great advantage with some drives and is a practice that might easily be followed to a much greater extent than is done at present. It enables the operator to know the load he is putting on the motor and teaches him to take a greater interest in the electrical end of the equipment. Again, on ma-

chines where a certain fixed production is required or where it is desired to obtain a uniform feed, this can often be gaged by an ammeter in the motor circuit better than any other method. Should trouble occur, either electrical or mechanical, the ammeter will show it at once and in many cases repairs can be made before anything serious happens. The foregoing will in most cases more than cover the cost of the ammeter.

In conclusion it may be said that a little thought and study of the conditions under which the equipment will operate when installed should be made, and the best type of overload protection should then be selected to meet these conditions.

"Lettgo" Mechanical Overload Release

When operating motor-driven machinery a circuit-breaker is usually depended upon to prevent overloading the motor. In other instances a shear pin is used to disconnect the driving power from the driven machinery when the load becomes excessive, but invariably a larger pin will soon be used, thus forming an element of danger to the machinery.

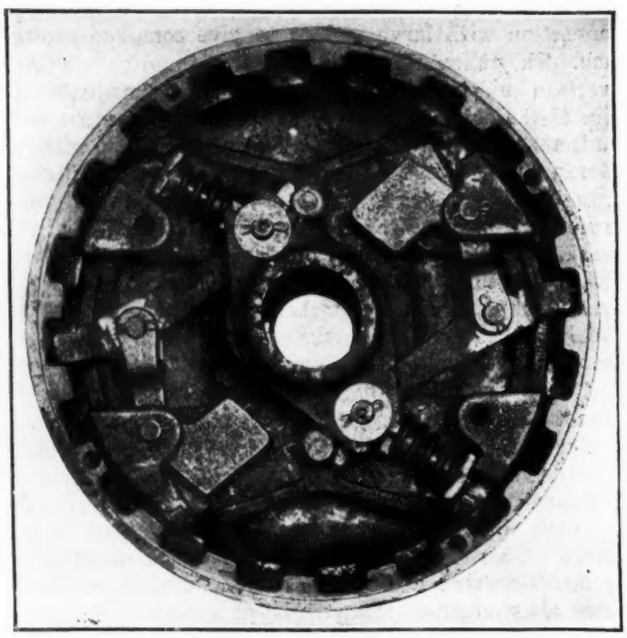


FIG. 1. DEVICE IN DRIVING POSITION

In order to eliminate this danger the "Lettgo" overload release has been designed to automatically disengage the driving power from the driven machinery if the load exceeds a predetermined amount. The device will take care of an overhead gradually applied as well as an overload suddenly applied. It can be set so that it will not trip out from sudden jars or shocks such as are received in the case of a shearing machine. The springs are arranged to adjust the tension so that the release will operate at the proper load, and no matter how often it operates, the right factor of safety is maintained. The mechanism is inclosed and can be packed with grease to lubricate operating parts.

Fig. 1 shows the device in the driving position, except that the triggers are not against the shoulders at the periphery. Fig. 2 shows it in the release position, and Fig. 3 is a line drawing better showing the construction.

Referring to Fig. 2, the spider *A* keyed to the shaft *B* has triggers *C* pivotally mounted on the links *D*, with

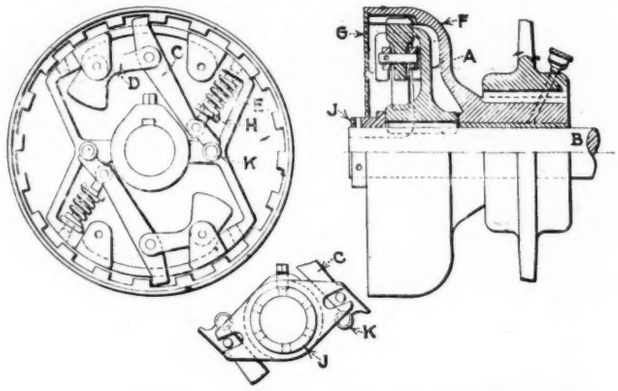


FIG. 2. SHOWING THE DETAILS OF CONSTRUCTION

the ends engaging inside notches in the rim of the drum *F* and roller *K*. Springs *E*, regulated to any desired pressure by the adjusting nut *H*, hold the ends of the

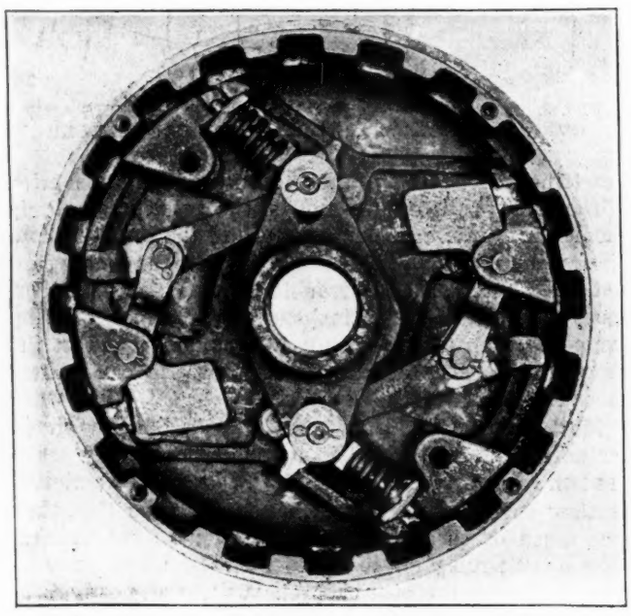


FIG. 3. DEVICE IN RELEASE POSITION

triggers on the rollers *K* under normal conditions, but when the drive is overstrained the compression of the springs will permit the ends of the trigger to drop into the position shown in Fig. 3, releasing the connection with the rim *F* and allowing the driven machine to stop.

This device has been patented by Frank E. Aurand, 123 South Cuyler Ave., Oak Park, Ill.

A cement for leather belting may be made from equal parts of common glue and American isinglass. Place in a kettle and add sufficient water to cover, and soak for ten hours. Then bring the mixture to the boiling point and add pure tannin until the whole becomes ropey and appears like the white of an egg. Apply it warm. Buff the surface of the leather where it is to be cemented, apply the cement and rub the joint tightly together. Then let it dry for five or six hours.

The Electrical Study Course—Alternating Pressures and Voltages

Hydraulic analogies are given of alternating pressures, and then it is shown how, when a single conductor is revolved in a magnetic field, there is an alternating voltage generated in it.

CONTINUING the analogy of the preceding lesson, let us assume that we have a water cylinder with its two ends connected through a pipe, such as that illustrated in Fig. 1, and the whole system filled with water. Assume that a gradually increasing pressure is applied to the piston, to cause it to move to the right, so that this force will reach a maximum value when the piston has made one-half its travel. On the last half of the travel assume that the force on the piston gradually decreases, so that when the piston has completed its stroke the pressure has dropped to zero. This will cause the water to flow from *A* around to *B* through the pipe in the direction of the arrow *a*. After the piston has completed its stroke, assume that the force applied to it is reversed and gradually builds up so that it reaches a maximum value when the piston is at the midpoint on its return stroke, after which the pressure again gradually decreases and becomes zero when the piston has again reached the end of its stroke. This time it would cause the water to flow from *B* through the pipe into *A*, in the direction of the arrow *b*. The force applied to the piston in Fig. 1 may be represented by a curve to show the increase and decrease in pressure, in the following manner:

Draw a horizontal line such as *xy* in Fig. 2 and suppose that the distance *ab* upon it represents the length of the first half of the stroke of the piston to the right and *bc* the length of the second half of the stroke;

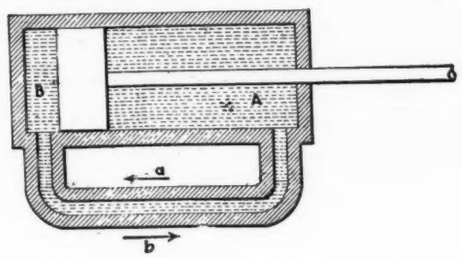


FIG. 1. CYLINDER WITH BOTH ENDS CONNECTED THROUGH A PIPE

likewise that *cd* represents the first half of the stroke to the left and *de* the second half of it. Furthermore, assume that the pressure on the piston is represented by vertical distances above and below the line *xy*, pressures to the right being represented by distances above the line and pressures to the left by distances below it. Let the maximum pressure be laid off equal to *v* and *w* respectively. At the beginning of the stroke to the right the pressure is zero. Since zero pressure is situated on the line *xy*, the first point *a* must be the first point of the curve, because it represents both the beginning of the stroke and zero pressure. When the piston has traveled the distance *ab*, the pressure has risen to a value *v*, and the second point on our curve will therefore be *f*. At *c* the pressure has again dropped to zero, so that *c* is the next point. From *c* to *d* the pressure is to the left, reaching its maximum at *d*, as indicated by *g*. Finally, at *e* the pressure is once more zero, giving the zero point at this location. If the pressure had varied uniformly, we could join the points with straight lines, as shown, but since that condition would hardly obtain, we might expect the pressure to increase and decrease perhaps after the fashion of some such curve as that drawn through *a*, *f*, *c*, *g* and *e*, in Fig. 3. It is evident that the shape of the curve may assume many different forms depending on the variation in pressure, but that there will always be a loop above the line *xy*

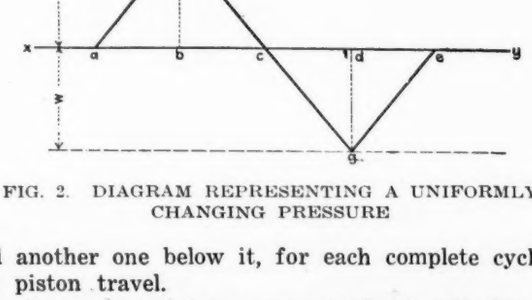


FIG. 2. DIAGRAM REPRESENTING A UNIFORMLY CHANGING PRESSURE

and another one below it, for each complete cycle of the piston travel.

In the curves we have represented not only the pressure, but also the flow of water. The flow of water will vary in value and direction as the pressure applied to the piston. Then the curve above the line *xy* will also represent the flow of water in the direction of arrow *a*, and the curve below the line flow in the direction of *b*. The two curves represent what is called a cycle, that is, they represent the complete operation of the piston. The piston started from the left-hand end of the cylinder, moved down to the right-hand end and returned to the left-hand end, where it started from, making a complete operation, or cycle.

Let us now turn to a consideration of alternating electric pressures; that is, voltages. The simplest condition is that of a single conductor revolving around in the field of a two-pole magnet similar to that shown in Fig. 4. Assume that the magnetic field is uniformly distributed as indicated by the vertical dotted line between the pole-pieces and that the conductor revolves in a clockwise direction in the path marked by the dotted circle. According to the rule for the direction of a voltage generated in a conductor moving in a magnetic field, the conductor in the figure will have voltage generated in it away from the reader when under the N pole and up through the plane of the paper when under the S pole, as indicated by the cross and dot respectively on the end of the conductor.

When the conductor is in position *a*, Fig. 4, it will be moving vertically upward parallel with the lines of force and will not be cutting them, therefore no voltage will be generated in the conductor at this instant. The same is true of the conductor when it is in position *g*; at this instant it is moving vertically downward, consequently not cutting any lines of force. At *b*, *c* and *d* the conductor is cutting lines of force at different rates.

This is made apparent by considering the horizontal distance between a' and b', b' and c', c' and d', etc.

When the conductor moves from a to b, it has only cut the lines of force between a' and b', when it moves from b to c it cuts the flux between b' and c', and when moving from c to d it cuts the flux between c' and d'. The horizontal distance between b' and c' is greater than that from between a' and b', likewise that between c' and d' is greater than that from b' to c'. Consequently, if the conductor is moving at a uniform rate, the number of lines of force cut per unit of time are not equal,

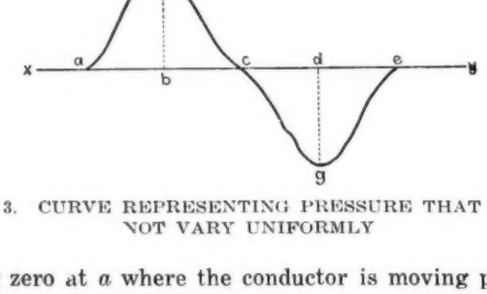


FIG. 3. CURVE REPRESENTING PRESSURE THAT DOES NOT VARY UNIFORMLY

being zero at a where the conductor is moving parallel with the lines of force, and at a maximum at d where it is moving at right angles to the lines of force. Therefore, since the voltage generated in the conductor at any instant is directly proportional to the number of lines being cut per unit of time, the voltage in the conductors will be zero at a and maximum at d, decreasing to zero again at g, and then reverses and builds up in the opposite direction under the S pole, reaching a maximum value at j and decreasing to zero again at a.

The next question that arises is, What is the value of the voltage in the conductor at the different positions in the revolution? It can be shown, and will be taken up in a later lesson, that if the vertical distance between d and the line xy (that is, the radius of the circle the conductor is moving in) is let to represent the maximum value of electromotive force, the vertical distance between the conductor and the line xy at any other point will represent the voltage generated in the conductor at that instant. In other words, if the vertical distance between d and xy represents the maximum voltage, then the vertical distances between b and c and the line xy will represent the voltage generated in the conductor at these points respectively. Therefore to construct a voltage curve, all that is necessary is to lay off on a line xy, Fig. 5, distances ab, cd, etc., representing the different positions of the conductor in its revolution, and at each of these points on this line draw a vertical, as shown. Then take the vertical distance between the conductor and the diameter xy, Fig. 4, and transfer them to the verticals erected at the points b, c, d, etc., on the line xy, Fig. 5, and draw a curve through the point thus obtained, as shown.

One of the curves is called an alternation and represents, as has been shown, the value of the voltage generated in a conductor when passing under one polepiece. The two alternations generated by the conductor when passing under the N and S poles is called a cycle. That is, the voltage has completed a cycle by first increasing from zero to a maximum value and back to zero in one direction and then reversing and increasing from zero to a maximum and back to zero in the opposite direction, just as the pressure in the cylinder did in Fig. 1.

In the problem of the preceding lesson it was required to determine the shortest length of brake arm that it would be possible to use on a prony brake designed to test a 50-hp. motor up to 25 per cent. above normal load, if 1000 r.p.m. is its rated speed and if the largest platform scale available is one of 200 lb. capacity. Since the motor is rated at 50 hp., the load upon it at 25 per cent. overload would be $1.25 \times 50 = 62.5$ hp. We know that the power indicated by means of a brake test is expressed by the equation

$$P = \frac{2 \times \pi \times S \times F \times L}{33{,}000}$$

where P represents the power in horsepower, S the speed in r.p.m., F the force in pounds registered by the scale, and L the length of the brake arm in feet. The value of π is of course 3.142, and the factor 33,000 is used to give the answer in horsepower instead of foot-pounds per minute, as it would otherwise be. Substituting the known values in the foregoing expression, we have,

$$62.5 = \frac{2 \times 3.142 \times 1000 \times 200 \times L}{33{,}000}$$

in which F is taken as the maximum capacity of the scale; namely, 200 lb. From the foregoing we find that $62.5 = 38.08 \times L$, and consequently

$$L = \frac{62.5}{38.08} = 1.641 \text{ ft.}$$

which is equivalent to 1 ft., $7\frac{11}{16}$ in. If the capacity of the scale were greater, the arm could be made shorter; and vice versa, if the capacity were less, the arm would have to be made longer.

A 25-hp. motor runs 825 r.p.m. and is connected to its load through a 9½-in. belt running on a pulley 10 in. in diameter. What is the pull in pounds on the belt when

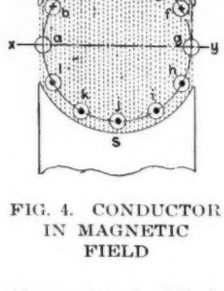


FIG. 4. CONDUCTOR IN MAGNETIC FIELD

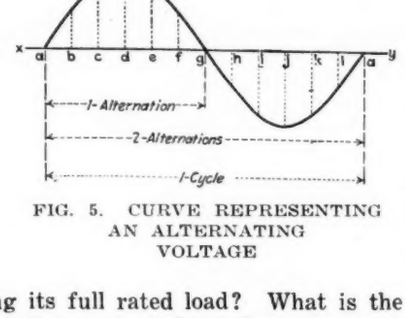


FIG. 5. CURVE REPRESENTING AN ALTERNATING VOLTAGE

the motor is driving its full rated load? What is the speed of the belt in feet per minute? If the motor operates from a 230-volt circuit and requires 95 amperes at full load, what per cent. efficiency does it operate at?

Effect of Soot in Chimneys

BY T. S. CLARK

A mistake not rarely made in the maintenance of a power plant operating with a tall chimney is the neglect to keep the bottom of the chimney free of soot, cinders and other matter carried over from the boilers. This material collects at times in considerable quantities, particularly when the boilers are being forced to a heavy overload, and may accumulate to a depth of several feet.

During the recent war power plants all over the country were called upon to produce more steam and to produce it quickly. Boilers old and new were pushed to

their maximum overload by any means at hand, irrespective of coal economy or any other economy. It was a question of more steam and more power at any cost. Under these conditions it was not unusual to overload the chimney by forcing the gases to its foot with the use of fans. From there a retardation of velocity took place and the matter carried in suspension was deposited in the foot of the chimney.

It is a fact that this material, though difficult to burn in the open air, will burn and glow under certain conditions when confined in the foot of the stack subjected to the chimney draft. High stack temperatures are produced. Explosions due to certain gaseous conditions are not unknown—a state of affairs that is liable to work to the detriment of a valuable and expensive structure and that is due wholly to neglect.

In a number of cases the writer has been called upon to examine the insides of chimneys where this condition of affairs has existed. Brick and steel adjacent to the accumulation in the foot of the chimney were found actually fused, indicating temperatures far over 1800 deg. F. Where the fusing of the steel took place, temperatures over 2200 deg. F. must have existed. Now, in these cases the chimneys were operated on boilers in boiler plants. Does the plant engineer want any stronger evidence of the importance of being watchful of the chimney and keeping it cleaned out?

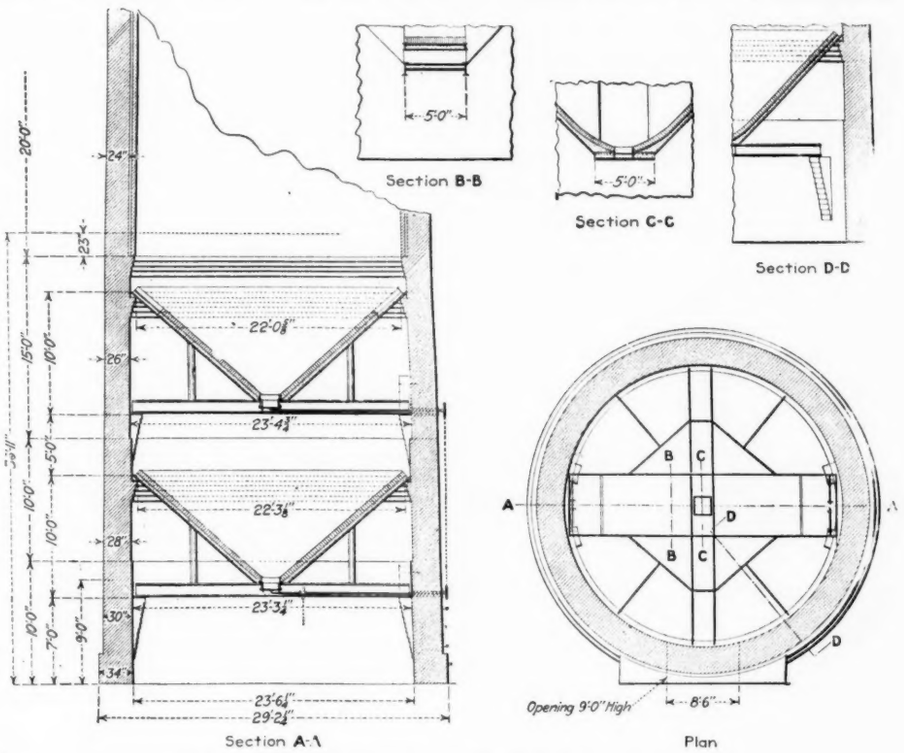
In chimneys of not unusual size a clean-out door is built in the wall at the foot, not as an ornament or as a place to advertise the builder's name, but for the specific purpose of cleaning. In the case of chimneys ranging from 250 to 500 ft. in height, and of unusually large diameter, where it is difficult to reach all the area at the bottom with a long-handled shovel or a long hoe, special means are provided for cleaning. A slanting floor is sometimes built on the interior, just below the flue opening, leading to a chute or thimble built into the walls of the structure, through which, with the help of an iron bar on a rake, the débris may be removed.

The large radial brick chimney 300 ft. high and 19 ft. in diameter inside at its top, built in 1917 for the Arlington Mills, Lawrence Mass., by the Alphons Custodis Chimney Construction Co., presents a novel and efficient method for the removal of soot and cinders from a chimney of great interior area. Below the flue opening in the interior of the stack two superimposed hoppers were installed, as shown in the vertical section. The frame was built of structural steel and the floor of reinforced cinder concrete, lined with brick. Two hoppers were used in order that the door in the lower one might be closed while that in the upper one was open. This prevented any chance of an open draft up the chimney through both hoppers.

While the lower hopper is receiving its charge of soot from above, the door in this hopper is closed. Doors were provided in the chimney at grade, large enough to allow a cart and team to back in under the lower hopper. The material is dumped into the cart by opening the door in the lower hopper, the door in the upper hopper being previously shut. Means of access to each hopper were provided through a manhole near the top. These openings were reached by an outside ladder built into the walls of the chimney. Around the upper rim of each hopper is a gallery from which a man, if necessary, can assist in a thorough cleaning of either hopper.

Two explosion areas were provided in the floor of the upper hopper. This was accomplished by building into the floor iron-plate doors hinged to open upward. This precaution was taken to relieve any pressure that might occur in the closed area between the hoppers.

Of necessity the chimney of a power plant has to keep pace with the development of the engine, turbine and boiler, in size and capacity. It has taken its place as one of the most important adjuncts. It represents in many cases investments ranging from ten thousand to over a hundred thousand dollars. Too many cases have occurred where the chimney has not been given the small and necessary attention of an inspection or a cleaning out of the bottom that the investment in the structure warrants.



SECTION OF CHIMNEY SHOWING SOOT HOPPERS

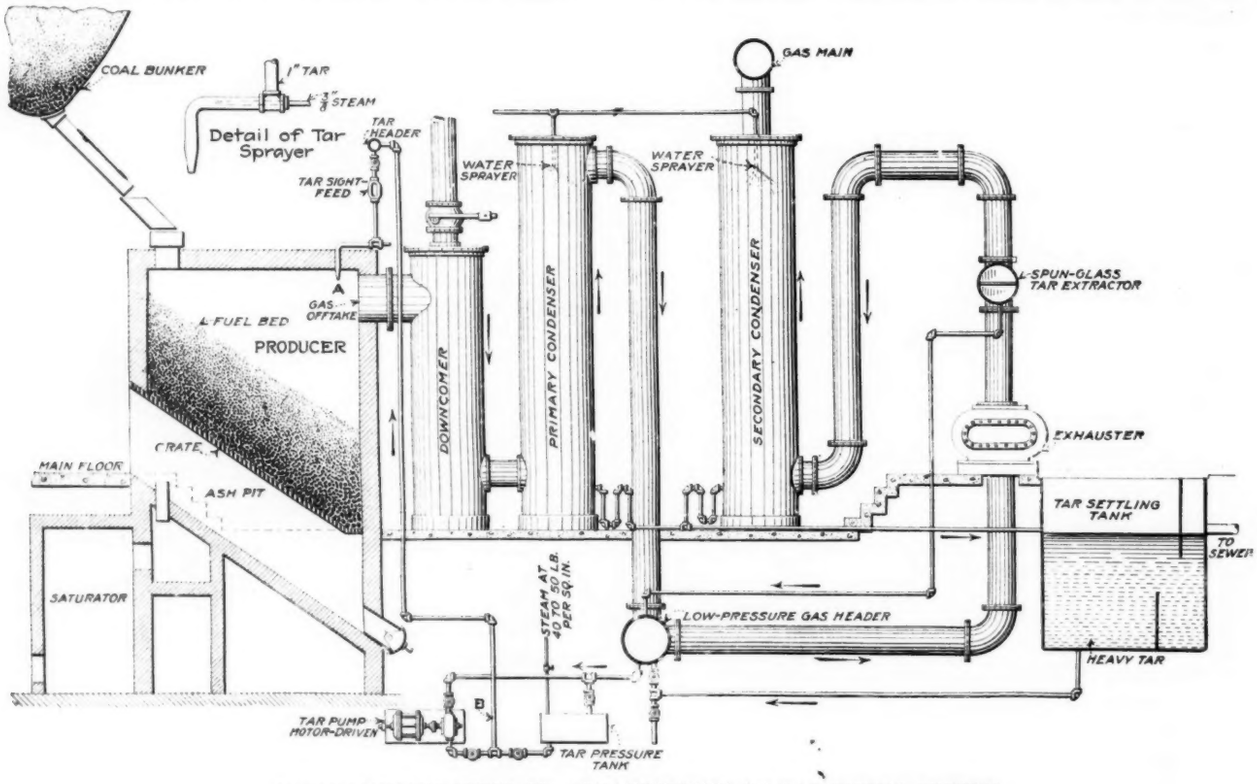
The occupational classification of people employed in the United States is as follows:

		Per Cent.
Agriculture, forestry and animal industry	12,666,000	33.2
Manufacturing and mechanical industries	10,855,000	28.4
Trade retail, wholesale and miscellaneous	4,347,000	11.4
Domestic and personal service	3,795,000	9.9
Transportation	3,199,000	8.4
Professional service	1,713,000	4.5
Extraction of minerals	1,060,000	2.8
Public service	533,000	1.4
Total	38,168,000	100.0

Tar Disposal in Ford Producer-Gas Plants

Disposal of producer-gas tar by burning it under boilers offered so many objections that a method of returning the tar to, and vaporizing it in, the producer was developed. So far as known it is the first time that this method has proved a success in practice.

IN THE manufacture of producer gas there is formed a large amount of coal tar, which passes over with the hot gas in the form of a vapor and, when cooled, condenses into a tar fog consisting of finely divided particles that remain in suspension. This tar must be removed from the gas to avoid clogging of gas burners, sticking of engine valves and obstructing of gas-pipe lines. Along this line the Ford Motor Co. is doing the unusual in that the tar is returned to the producer, discharged over the fire and successfully vaporized. The accompanying diagram of piping and much of the descriptive matter of this article apply particularly to the gas-producer installation of the plant at Ford City, Ontario, but are also more or less typical of the Highland Park and Dearborn plants. For a general description of the Ford City plant reference may be made to *Power* of Aug. 6, 1918.



DIAGRAMMATIC VIEW OF ARRANGEMENT OF TAR-PIPING SYSTEM

Referring to the diagram, the path of the gas is from the producer through the downcomer and primary condenser to the low-pressure gas header. The gas from the several producers comes together at this point. The several gas exhausters receive their supply from this header and discharge through spun-glass tar extractors in parallel, thence through secondary or cooling condensers to the gas-distribution main or header. Considerable tar is removed from the gas by water sprays in the primary condensers and practically all the remaining tar is removed by the spun-glass tar extractors. A trace is removed by aftercooling water sprays in the secondary condensers.

At present the cooling water from the primary and secondary condensers is mixed and sent to the tar-settling tank where most of the tar settles to the bottom. The water from the secondary condensers in a short time will be diverted directly to the sewer, thereby increasing the efficiency of tar separation from the primary water. The low-pressure gas header acts as a tar receiver. The tar flows by gravity, assisted by the head of water in the settling tank and the gas-exhauster suction, from the tar-settling tank to the low-pressure gas header. The tar from the spun-glass extractors likewise flows back by gravity to this same gas header, assisted by the difference in gas pressure on the two sides of the exhausters.

Previous to 1916 the tar was a waste product of the gas-producer plant and was hard to dispose of on account of its pitchy nature and the impurities it contained. It was got rid of by being sprayed into the boiler furnace. The small saving in fuel in no way repaid for the nuisance of the frequent plugging up of the tar lines, clouds of black smoke from the stacks and the mess in the plant.

It seemed desirable to dispose of this tar by gasifying it in the producer. All efforts along this line previous to August, 1916, had been so uniformly unsuccessful that it was generally admitted at that time that the idea was not practicable. However, on the suggestion of H. F. Smith, of the Smith Gas Engineering Co., who had previously done considerable work on the prob-

lem, another attempt was made at the Highland Park plant, which established the fact that the tar could be gasified and would increase the heat value of the gas. Profiting by this experimental work, when the Ford City plant was put into operation the producers were piped up to dispose of all tar. The development of details has been rapid. The several plants differ materially in respect to details of construction and operation, yet the essential features are the same and each accomplishes the same general results.

Temperatures are the most important factors in the handling of the tar. Good practice requires that the gas leave the producer at a temperature of approximately 1000 deg. F. In the primary condenser the gas should be cooled down to about 125 deg., this being about the lowest temperature at which the tar remains liquid. If cooled too much, the tar particles will stick and build up on the spun-glass extractors. The temperature of the gas leaving the secondary condenser should be as low as the water supply available will permit in order to eliminate the last trace of tar and moisture.

Methods of Forcing the Tar to the Sprayers

The tar that is collected in the low-pressure gas header in the basement may be pumped to the tar sprays in each section of the producer by a small rotary pump. The speed is regulated so as to return the tar at a slightly higher rate than it is received from the tar extractors and tar-settling tank. The pump may then be shut down, if desired, at times of light load.

As an auxiliary to the pump a small pressure tank is installed below the low-pressure gas header. The tar flows by gravity into this tank, which has an overflow so that the small amount of water that may accumulate can be drawn off. When the tank is full of tar, the connections are closed off and steam is admitted at a pressure of from 40 to 50 lb. per sq.in. The tar is discharged through a pipe from the bottom of the pressure tank and delivered to the producer sprayer *A* through the same pipe line *B* into which the tar pump discharges.

The advantage of the pressure-tank method of handling tar is that it has no moving parts and the pipe line and all connections are blown clean of the tar by the steam after the tank has been emptied. On the other hand, the tar pump has the advantage of giving a more constant feed of tar to the sprays.

In the Ford City plant a 96-gal. pressure tank is used in preference to the tar pump. The objection to an intermittent supply of tar to the fire has recently been overcome by first delivering the tar to an overhead storage header running the full length of the battery of producers. The tar sprays are supplied continuously from this header. With continuous operation and constant maintenance of temperature throughout, it has been found possible to keep the tar so fluid that it is being fed like oil through sight feeds to each section of each producer.

The sprayer by means of which the tar is atomized and distributed over the fuel bed is made by placing a ¾-in. steam pipe inside a 1-in. tar pipe. The ends of the steam pipe and tar pipe are reduced in area so as to increase the velocities of the steam and tar to aid in the atomizing. The ends of the sprayer are approximately flush with the bottom face of the top lining of the producer.

Vaporizing the tar increases the heat value of the gas about 10 to 15 B.t.u. per cubic foot. The difference shows up in the analysis of the gas in an increase of from 1 to 2 per cent. of methane, accompanied by a slight reduction in the percentage of hydrogen.

The chief trouble encountered when first returning the tar to the producer fire was the formation of soot when the tar was sprayed onto a fire that had holes in it. This soot, if allowed to accumulate, would plug up the spun-glass screens in the tar extractors in a very few minutes. It is necessary to keep the fuel bed in good shape and free from holes when spraying tar. The tar should be evaporated over the full area of the fuel bed and not burned as would be the case were there a hole in the fire. Five sprays are employed to insure even distribution over the fire. With a smaller number the fuel bed under each spray became saturated with tar.

In the past considerable trouble has been experienced from solidifying of the tar in the pipes when the pump was shut down. This may come about due to cooling or to "baking." If the tar is allowed to cool in a pipe line, it is difficult to get it moving again. Provision is therefore made in every case for blowing tar from the pipe lines by the use of a ½- or ¾-in. low-pressure steam line run either inside the tar pipe or, preferably, on the outside and inclosed in the same pipe covering. The pressure on these steam lines should be five pounds or less. Tar should not be allowed to remain quiescent for any considerable length of time in a pipe even though heated, since the lighter oils will distill off and the residue harden or bake in the pipe, making a condition as bad as or worse than when it solidifies owing to cooling. The new sight-feed tar system requires that the temperature of the tar be maintained at about 160 deg. F., and for this purpose a low-pressure steam pipe is run inside the tar header over the producers.

Efficient Use of Water Power

By W. F. Uhl

Perhaps the subject of this article is not so important as the efficient use of fuel, as there is not nearly so much water power in existence as fuel-produced power; but anything that can be done to reduce the demand for fuel and at the same time increase the amount of available power is of great importance at this time. The water powers were at least partly responsible for the early lead that New England took industrially. Yet the growth of industry was so rapid that these powers soon proved inadequate, and where in the beginning most water powers were supplemented by some steam power, at the present time, with a very few exceptions, most New England water powers are mere adjuncts to steam power plants.

Redevelopments that have been made have been mostly of a partial nature, such as the replacement of turbines, often of doubtful advantage as to efficiency, but sometimes producing increased power when plenty of water is available. Generation of electric power has brought about some changes in these conditions, and a few of the more favorably situated water powers have been redeveloped along fairly modern lines. Heretofore the redevelopment of many of the existing water powers was of doubtful advantage considered purely from an investment basis, and under past conditions there was, with a few exceptions, no other proper measure of judgment available.

The question generally resolved itself into one of a saving in the coal pile. If additional money spent on the water power showed a saving in the yearly coal bill, it was justified; if not, the old plant could be operated until repairs became excessive and then it must be abandoned. There were a few exceptions to this rule in the case of those plants where the dam and sometimes other parts of the hydraulic development had become adjuncts to the more important steam plant for condensing purposes or for the use of water for manufacturing purposes, in which case such part of the water-power development could be partly or wholly charged to the steam plant or to manufacturing, or both. Again, in some plants a part of the machinery is often run overtime or at night, and it might prove fairly uneconomical to run the steam plant for such a small load, whereas the smaller water power might be used at small cost.

A Decided Change in Conditions

There are other such special cases which in the past have justified the redevelopment of some water powers that might not otherwise have proved desirable. But all these measures have now changed. It is no longer a question of a proper investment where power is concerned, but a question of getting reliable power at any cost. Nor are conditions ever likely to return to those of a few years ago. Even if fuel can again be obtained in any quantity desired, who doubts that its cost will be much greater than it has been in the past? Furthermore, there is always the danger of another crisis and a small amount of water power will be better than no power at all.

Assuming that no further argument is necessary to establish the fact that the water powers of the country, wherever there is a use for power, can generally be developed or redeveloped to economic advantage, it is of the greatest importance that they be so developed that the most power possible can be obtained from them. This does not mean that equipment of great capacity should be installed, but that such equipment as is installed shall be highly efficient in the use of the available water, always remembering that the fatal weakness of water power is its variableness.

The size of a manufacturing plant that a water power can continuously operate, or the size of a fuel-burning plant necessary to supplement a water-power plant, is dependent upon the minimum power that can be obtained at any one time from the power. It is therefore important not alone from the standpoint of saving in fuel that the water power be efficient, but also from the standpoint of dependence that can be placed on it.

Advance in the Art of Hydraulic-Turbine Design

The advance in the art of hydraulic-turbine design and installation in the last ten years has been marked, and modern installations properly made average about 85 per cent. efficiency, with a maximum of 90 per cent. This represents an increase of 20 per cent. in power and can be obtained with no more water but simply through more efficient use of head and water formerly used.

One of the rivers in Massachusetts, the total drainage area of which is about 400 square miles, has over twenty small power developments with heads varying from 8 ft. to 23 ft., a total development head of about 320 ft. and a rated turbine installation of about 7500 hp. Of this, 4500 hp. is used for 24-hour power and 3000 hp. for 10-hour power. Most of the turbines were installed some time ago, and their average efficiency is probably about 65 per cent., with a maximum of 75 per cent., while the actual maximum output is probably not over 6500 hp.

Some of the present developments would justify larger installations. Through a proper redevelopment of the present powers on this river, it is estimated that 21,500,000 kw.-hr. more could be obtained in the average year, at a cost that would be within commercial limits on a fuel-saving basis.

Cost of Storage Reservoirs

Storage reservoirs, although highly desirable wherever they can be commercially developed, would not show commensurate results on this river. The first cost would be very high principally on account of their number and small capacity and on account of the diversity of interests of the users. On rivers where there is a diversity of interests some plants running 24 hours daily and others for shorter periods, or where the heads are low and the ponds small, or any combination of these circumstances exists, it is always impossible to make full use of the stored water. One of the chief difficulties would be to let water out of the reservoirs in such a way that it would arrive at each plant at a time when it could be used. Under most cases of this kind probably not more than 50 per cent. use of storage would be made.

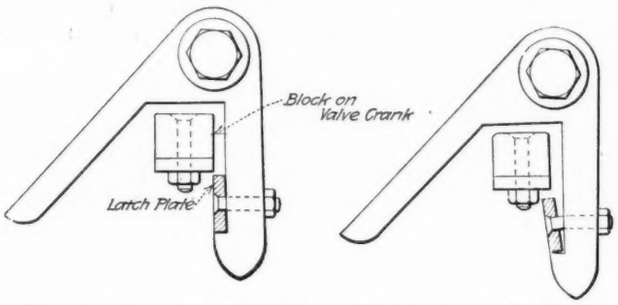
The investment warranted for storage in such a case would then not be over about $0.60 per million cubic feet per foot of head. One million cubic feet of stored water under one-foot head is equivalent to about 18 kw.-hr. on the power-plant switchboard, assuming 100 per cent. use of stored water. Probably $0.0075 per kw.-hr. is a fair average for the value of coal saved by stored water. This would be the case on the basis of 2.5 lb. of coal burned per kilowatt-hour in a steam plant with coal at $6 per short ton. The saving on account of fuel due to 18 kw.-hr., or one million cubic feet of storage water per foot of head, is then about $0.75 \times 18 = 13.5$c. Control and maintenance of reservoirs would probably average 1.5c. per million cubic feet per foot of head, which would leave a net saving of about 12c. per million cubic feet per foot of head. Capitalized at 10 per cent., this would warrant an expenditure of about $1.20 per million cubic feet of stored water per foot of head, assuming that it is used completely for every foot of head.

On a river where there are a number of powers, each with a considerable head and a pond of considerable capacity, all owned by the same interests, it is possible to use stored water almost completely in some years. In other years it may be difficult to make use of much storage, either because it is an exceptionally wet year or because the reservoirs did not fill in the spring. It is exceptional to find 75 per cent. use of stored water where there is a diversity of interest, and in most cases 50 per cent. is probably nearer the actual figure.

Sometimes the pistons of duplex pumps do not make full stroke in starting. This is usually caused by too tight packing of the stuffing-boxes. To prevent leakage where the boxes are properly packed it is only necessary to draw lightly on the glands, thereby saving friction. Steam valves are given the proper position by the manufacturer before shipment. When difficulties ensue in the operation of the pump, investigate the water end first before disturbing the adjustment of these valves.

Flywheel Accident at Corinth, N. Y.

On Mar. 9 a flywheel exploded in one of the paper mills of the International Paper Co., at Corinth, N. Y. The wheel was mounted on the shaft of a Corliss engine. It was 15 ft. in diameter, had a 50-in. face, and contained two double sets of arms, there being altogether twelve spokes in the wheel. It carried a double leather belt 48 in. wide.



HOW LATCH BLOCK CAME LOOSE AND LOCKED TO VALVE CRANK

In this accident the flywheel not only was completely demolished, but there also was demolished a receiving pulley 70 in. in diameter and 50-in. face, containing twelve arms. The engine was damaged very little, but some of the pieces of the flywheel were hurled through the floor and others through the ceiling into a paper machine, which was more or less damaged.

The cause of the accident was centrifugal force due to the racing of the engine. The racing was caused by the loosening of the latch plate on the hook of the valve mechanism. This loosening of the latch plate prevented the knockoff mechanism from disconnecting the hook from the valve crank, as a result of which the engine took steam full-stroke on that end. The load being light at the time, the speed increased until the main driving belt broke. Then the engine, free of all resistance due to its load, raced and burst the wheel by excessive centrifugal force.

There is a very good lesson in this accident—one that most operating engineers will thoroughly appreciate. It appears that the latch plates on the hooks of this engine became loose or were broken off so frequently that a stock of these plates, together with their attachment bolts, was kept on hand. When a broken bolt was replaced, no one seemed to have tried to increase the strength of the bolt so that a recurrence of the accident would be unlikely to happen. But when this serious accident followed—namely, the explosion of the flywheel—then a suggestion was offered for the strengthening of the bolt. This suggestion consisted of a recommendation that the new bolt be an ordinary standard S. A. E. bolt with castellated nut, cotter-pinned in place. This bolt not only is made of a better grade of material, but the threads, being finer, will give a greater area to resist fracture than the other type. Then, too, the castellated nut, cotter-pinned on, will prevent the loosening and the consequent hammer blow shock tending to further damage or breakage.

Chart for Finding Coal Loss in Percentage of Coal Fired

By D. G. Beaman

The easily read chart shown herewith should be useful to power-plant engineers, enabling them to readily find the coal loss during combustion, expressed in percentage of the coal fired.

To read the chart, assuming the figures given below: From a point indicating 6 per cent. CO_2 on the scale at the bottom of the chart (as indicated by the dotted line), proceed vertically to the curve marked 700 deg. F., the flue-gas temperature. The proportion of the heat in the coal fired which is going out with the flue gases is given by the scale at the left as 56 per cent.

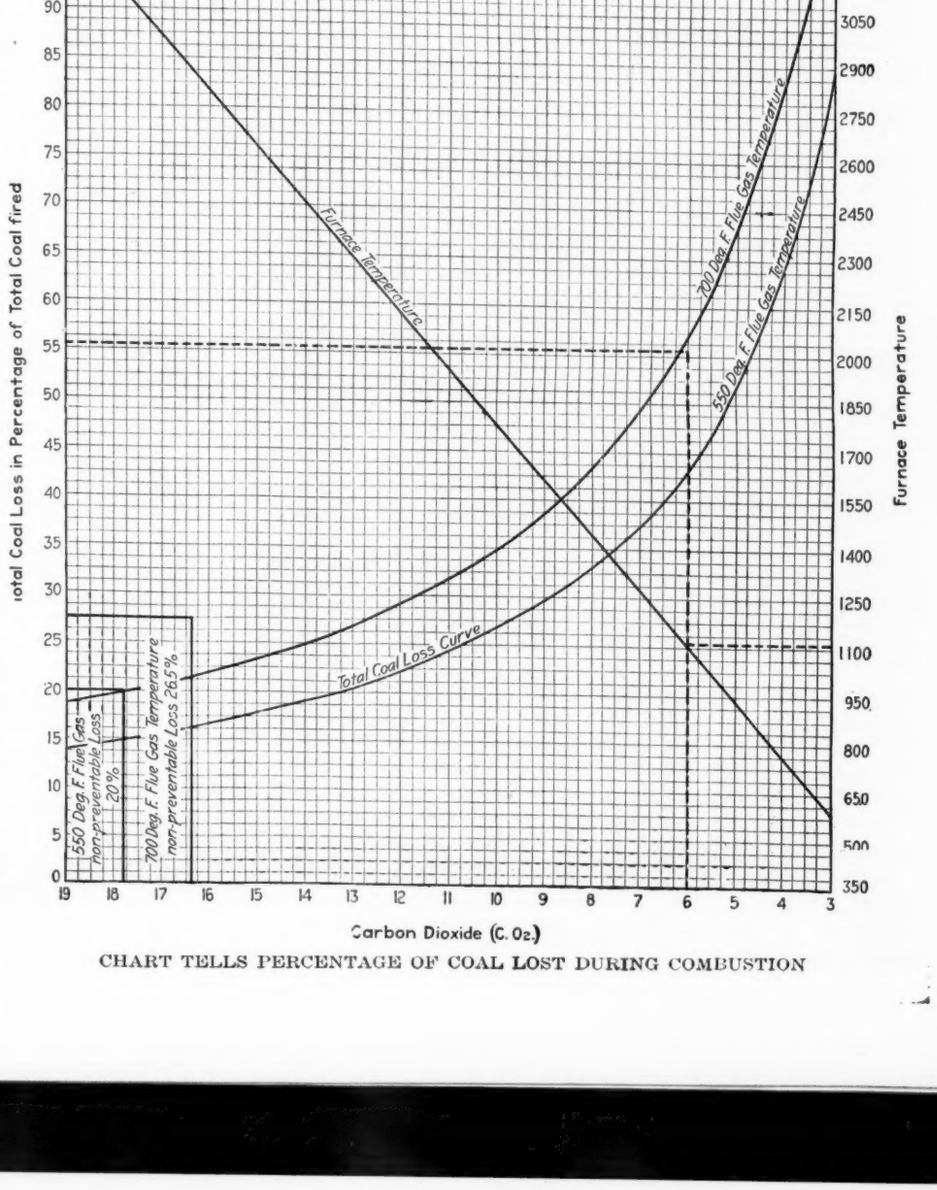

Total Coal Loss in Percentage of Total Coal fired
Furnace Temperature
Carbon Dioxide (C. Oz.)
Furnace Temperature
Furnace Temperature
700 Deg. F. Flue Gas Temperature
550 Deg. F. Flue Gas Temperature
Total Coal Loss Curve
550 Deg. F. Flue Gas — non-preventable Loss — 20%
700 Deg. F. Flue Gas Temperature non-preventable Loss 26.5%

CHART TELLS PERCENTAGE OF COAL LOST DURING COMBUSTION

Rear Head of Steam Drum Fails

An explosion due to the failure of the rear head of a steam drum on a B. & W. (English built) boiler, occurred on the morning of June 12 at the works of Wm. Crane & Sons, Newmarket, Ont., Canada. The failure occurred at the flange where the head was riveted to the drum. The building in the immediate vicinity of the boiler room was wrecked, the escaping steam and falling débris causing the death of five persons and severe injuries to several others.

The boiler was nine tubes high by fourteen tubes wide and was of the ordinary double-drum type. Fig. 1, a view of the steam drum, shows that the drum head was defective for about three-quarters of its circumference, in the part below the water level. It is evident from the illustration that the fracture occurred at the bottom of the head, for the protruding piece of the head at the top is turned upward, after which the head sheared from this upper portion and was blown through the roof.

Fig. 2 shows the head from the inside, also the manhole plate in place. A 6-in. stop valve was connected to the back end of an equalizing connection, and an auxiliary line supplied steam to dry kilns, etc., Each drum had a 4-in. safety valve.

An examination of the boiler disclosed three primary conditions. First, the fractured head showed an area of defective metal that extended around the circumference from about 45 deg. above the center line on each side, as shown in Fig. 1; second, the rest of the metal seemed to possess its original qualities, as indicated by the elongation of the metal before it was finally torn from the major part of the head; third, the 6-in. steam pipe had parted from the elbow, the threads of which were found stripped for about five threads back. The

FIG. 1. END OF STEAM DRUM, HEAD BLOWN OUT

equalizing header, on which the 6-in. connection was mounted, was found bent back about 20 deg. from the normal position. This, it was argued by the editor of *Power House*, from which our illustrations are taken, was probably the initial cause of the explosion, the sudden escape of steam and the accompanying water-hammer effect blowing out the already weakened head.

The fracture was not continuous through the rivet holes, but followed an irregular line in some cases, leaving considerable metal around the rivets. Chiefly, however, the crack followed along the line of the rivets. It appears that the fracture in the head had existed for some time.

A number of boiler explosions have occurred in which cracks have been discovered from rivet holes to the surrounding plate, or from rivet hole to rivet hole, or from rivet holes to the edge of the plate. The devel-

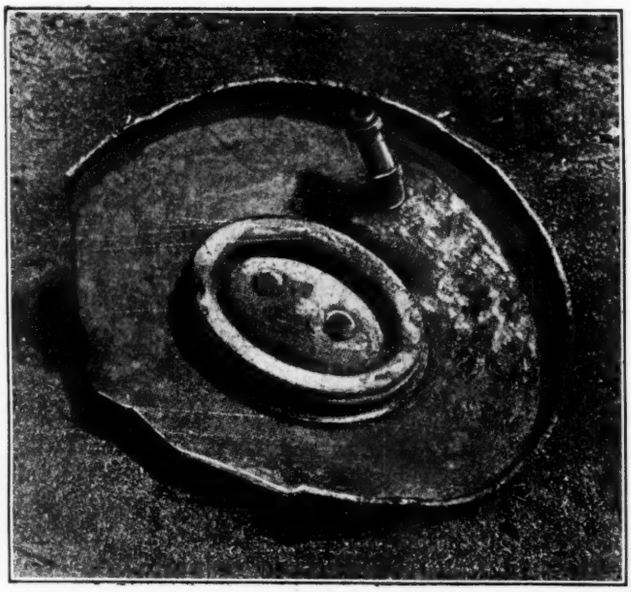


FIG. 2. VIEW OF DRUM HEAD, SHOWING FRACTURE

opment of these cracks usually occurs below the water line and generally in conjunction with a leak, and the deterioration of the boiler metal may be due to the embrittlement of the steel, resulting from caustic soda used in the feed water. It is possible that the boiler head under discussion contained fine cracks, as has been found in other instances, due to the presence of caustic soda, which will, if of sufficient strength, attack iron with the generation of hydrogen.

Workmen's Compensation Act Applied

The Pennsylvania Workmen's Compensation Act provides for the payment of awards on account of injuries to employees by accident in the course of their employment and while actually engaged in the furtherance of the business of the employer.

In the recent case of Messer vs. Manufacturers' Light and Heat Co., 106 Atlantic Reporter, 85, it appeared that plaintiff's husband was employed by defendant as engineer in a pumping plant. At the request of his superintendent he went to inspect another pumping station with a view to increasing his efficiency. On his way homeward from this trip he was fatally injured in an automobile accident, and his widow applied for allowance of an award under the Compensation Act.

The application was resisted, but the Pennsylvania Supreme Court holds that plaintiff was entitled to recover, on a theory that at the time of the accident he was acting within the scope of his employment and in furtherance of his employer's interests, although not then actually engaged in operating the defendant's pump.

EDITORIALS

Gas-Steam Engines

A GAS-STEAM engine, named after its inventor, the Still, has been tested in England under the supervision of Prof. C. Vernon Boys, F.R.S., and is described in this issue. The engine utilizes steam generated from the heat now lost to the water jacket and exhaust.

The gas-steam engines at the Ford plant in Detroit are well known. The heat in the exhaust gases is taken out by a superheating receiver between the high- and low-pressure cylinders of a steam engine, and by a feed-water heater. The jacket water is used as boiler feed.

Power has previously suggested that, when the process of combustion under pressure is perfected, an engine taking alternate charges of steam and gaseous products of combustion under pressure would appear to offer a solution of the problems of both the steam and the internal-combustion engine. The problem with the steam engine is to keep the interior surfaces of the cylinder hot. The entering steam comes in contact with surfaces chilled by exposure to the exhaust of the previous stroke and by the evaporation of moisture from them during the exhaust stroke. The problem with the internal-combustion engine is to keep it cool, and something like one-third of the heat supplied goes off in the jacket water.

If a generator were practicable in which fuel were burned under pressure, so that the products of combustion could be used like steam in an engine cylinder, such a gas might be used for a stroke or two and then a stroke or two made with steam of the same pressure. The steam would find the cylinder bone dry, initial condensation would be avoided, and the relative use of the gas and steam could be so proportional as to keep the cylinder from heating above a safe temperature or from getting below the initial temperature of the steam.

Was Caustic Soda Responsible?

TWO explanations have been offered for the boiler explosion at Newmarket, Ontario, recorded in this issue: One that the initial failure occurred in the equalizer-pipe connection, the release of pressure, with the accompanying water-hammer effect in the drum blowing out the weakened head; the other, that the break in the pipe was secondary and that the failure occurred first in the head.

Either may have been correct, but it is conceded that the head was in a weakened condition. It is significant that the failure followed the line of rivet holes below the water line, and tore through the solid metal well up in the bumped portion above the water line. This indicates that the metal was weakened, apparently below the water line only, and precludes the theory that breathing action of the head might have been responsible; for in all such cases the failure has been completely around the knee of the flange, with greatly reduced thickness of metal in this region.

It would appear in the present case that the metal was brittle along the line of rivets or that there were cracks in this section, or perhaps both. We are told by one who saw the boiler recently that, although it withstood the hydrostatic test satisfactorily, when under steam leaks were observed around the flange of the head and that this section was coated with salts.

This points strongly to the embrittling action of sodium hydroxide.

It will be recalled that the engineering experiment station at the University of Illinois about three years ago made some investigations into the effect of caustic soda on steel in boilers and published the findings in Bulletin No. 94. The conditions that led up to the investigation were a number of head failures, all below the water line, in connection with leakage at seams and rivet holes and accompanied by an exterior accumulation of incrustation of a strongly alkaline character. In all these cases the water employed contained a considerable amount of caustic soda.

The investigation, although not carried to conclusion, indicated that caustic soda of sufficient strength attacks the metal, liberating hydrogen in the nascent state, which in turn affects the physical properties of the metal and produces brittleness.

Information is not at hand as to the character of the water used in the Newmarket boiler. Further discussion may throw more light on the matter. It is a problem close to many engineers and will bear considerable investigation.

Protection of Electric Motors

UNLESS electric circuits are properly protected, the equipment connected thereto cannot perform the duties for which it is designed, or else it is liable to serious damage in case of trouble, and the whole electrical system becomes a hazard to both life and property. Fuses were the earliest device employed to automatically open electric circuits in cases of emergency. These devices still have a wide field of application where they give sufficient protection to electric motors. One of the places where the fuse gives best protection is in direct-current motors that start under ordinary conditions and are not subjected to heavy overloads for any appreciable length of time, of which there are a vast number in use. In general the starting resistant of direct-current motors is designed so as to limit the current inrush at starting to about one hundred and twenty-five to one hundred and fifty per cent. of full-load current. This allows fusing the motor at about one hundred and twenty-five per cent. full-load rating, and the time lag of the fuse is sufficient to take care of momentary overloads. With an overload of one hundred per cent. on the motor and the circuit fused for one hundred and twenty-five per cent. of the motor's rating, the fuse will open the circuit in approximately thirty seconds, which is sufficient time for the cause of the overload to be removed, or the motor should be disconnected from the circuit, unless able to take care of

heavy overloads for longer periods than the standard motor is designed for. To protect the motor under the latter condition a circuit breaker having an inverse time element is required, adjusted to the overload that the motor is capable of operating under.

In the protection of polyphase motors two elements have to be contended with: namely, protection against overload from external sources and also single-phase operation, the latter causing the active phase to be overloaded if the machine is operating near normal load under polyphase operation. On account of the large starting current required by squirrel-cage-type induction motors, even under normal conditions, it is almost impossible to fuse the circuit so as to protect the motor during the starting period and also under operating conditions. The starting current, ranging as it does from three hundred to six hundred per cent. normal full-load value, leaves little opportunity of fusing a circuit to protect the motor against abnormal condition while running, if the starting period is of appreciable length, as is the case when starting heavy inertia loads. This has been met with the use of fuses in two ways. One is by having the fuses in the circuit only while running, which leaves the motor without any protection while starting, except the main fuses on circuit-breakers, which to say the least is objectionable. In the other method two sets of fuses are used, one in the starting circuit and the other in the running circuit. Of course, when the latter is used, the first cost begins to approach that for which overload relays, having an inverse-time element, can be installed. The relays will give complete protection to the motor both against overloads and also single-phase operation, except in extreme conditions which have to be taken care of by special means.

In an article in this issue O. C. Callow discusses the various types of protection for electric motors that are in common use. In his conclusion he points out that a study should be made of the conditions under which the equipment will operate when installed, and the best type of overload protection should then be selected to meet the condition. This, no doubt, is the best solution of the problem, so far as the installation is concerned. But after this is done there is the human element that must be considered in the operation, which no doubt causes more apparatus to be destroyed than improper choice of protection. There is little use of installing proper protective devices, whether they be fuses, inverse-time limit relays or what not, if the proper adjustments are not maintained. If the circuit is properly protected and some condition arises that causes the device to open frequently, the proper remedy is not a large or improperly filled fuse or a higher setting on the relays, or circuit-breaker; yet this is what is frequently done, especially where motors are cared for by incompetent attendants and the real cause of the difficulty is not located and remedied. It is this practice that is causing probably more failures of apparatus than anything else. Both fuses and other types of overload equipment have their respective field of application in the protecting of electric motors. However, so far there is not available what would be an ideal protection for electrical equipment—one in which the time of opening the circuit is a direct function of the heating of the motor, since as long as the motor does not reach a dangerous temperature, there is little reason for disconnecting it from the line. When such a device is available for all sizes of machines, considerable advance will have been made in the protection of electric motors.

Resuscitation from Electric Shocks

THE supplement "Resuscitation from Electric Shocks," published in this issue is a chart giving instructions for resuscitation from electric shocks by the "Prone-Pressure Method," as recommended by the Commission on Resuscitation from Electric Shocks, representing the American Medical Association, the National Electric Light Association and the American Institute of Electrical Engineers. This method of artificial respiration is equally applicable to resuscitation in all cases of suspended respiration due to drowning, inhalation of gas, smoke or fumes, as well as from electric shocks. The chart is an abbreviation of the booklet of rules for resuscitation from electric shocks, as revised by the National Electric Light Association. W. C. L. Eglin, chairman of the committee on Safety Rules and Accident Prevention of the N. E. L. A. in the preface to the booklet of rules, says:

> The revision of the rules and also the chart, which consists of an abbreviated form of these rules, has been based on field experience covering a number of years; and while no very radical changes have resulted, changes in detail have been made, which, it is felt, will make the operation of the method more effective and to which the careful attention of instructors and those familiar with the method is directed.

No power plant is too small to have someone trained in this method, and it is hoped that the publication of this supplement will cause the adoption of this means of artificial resuscitation in many plants, where at the present time means of resuscitation from electric shocks or otherwise is entirely lacking. To say the least, the committee has done a great humanitarian work in presenting these rules in so simplified a form; however, it remains for those in authority in the industrial establishments and electric-power systems to make them effective.

One going through engineering publications would get the impression that the steam reciprocating engine was on its last legs and about to become as rare as a diplodocus. Nothing is more preposterous. The steam engine has a wide field of application and will continue to be widely used. *Power* wants more articles on the reciprocating engine, articles of the practical kind particularly. They are more acceptable if short, of not more than a thousand or fifteen hundred words, and well illustrated by plain sketches and photographs. Let us have more articles that treat of its operation, care and maintenance.

In one of the discussions at the spring meeting of the American Society of Mechanical Engineers, a story was told of a test which showed an impossible performance. Careful checking of the log failed to reveal any discrepancy in the figures, the observations were uniform and consistent but the efficiency was unbelievable. Inquiry finally fastened upon the venturi meter with which some of the quantities were measured. "Oh that," said the engineer. "Yes, we had trouble with that at first, but I bored out the little passage in the middle, and it has worked fine ever since."

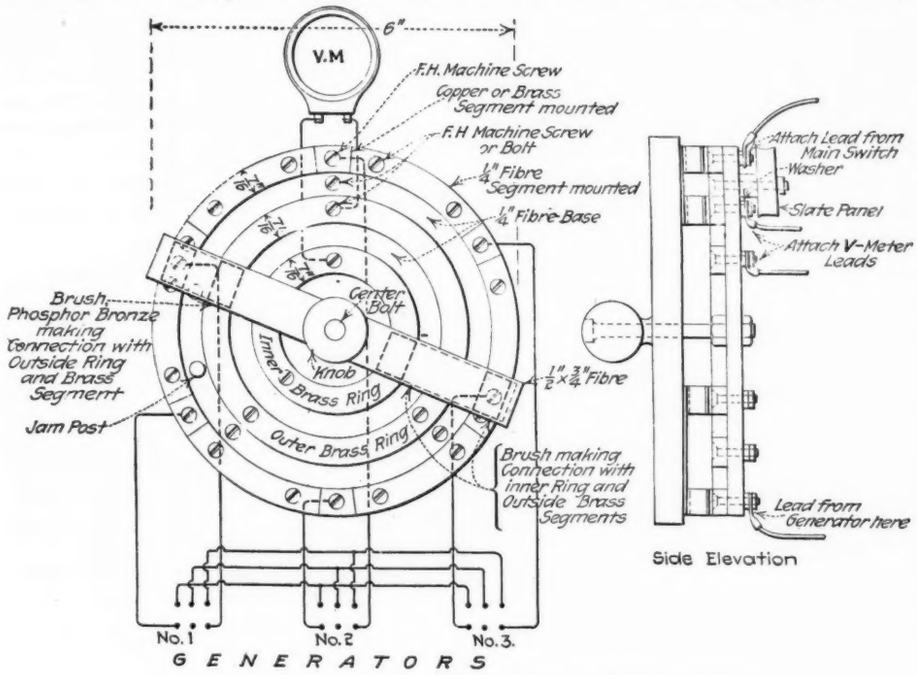
It is not so many years ago that a movement was started for the enactment of laws to limit the voltage of electric circuits to about 1000 volts. At the present time the indications are that the 220,000-volt system is a realization of no distant future.

Correspondence

An Inexpensive Voltmeter Switch

A voltmeter switch that I designed and have had in use for two years at two plants where we have three generators working in parallel is shown in the illustration. It is rather an expensive matter to have a voltmeter for every circuit, and as most people practice economy differently, there are many kinds of voltmeter switches on the market and very few good ones. It isn't the principle that gives the trouble; it is the switch.

My switch overcomes some of the objections found in so many types of switches, such as the following: The liability to injury from careless handling; liability to loosen and turn around; liability of contacts to get out of line and sieze; liability to spread a film of dust or metal from segment to segment and cause a short-circuit; liability to collect dust in pockets and destroy electrical connection in places; electrician's weakness.



PLAN AND SIDE ELEVATION F VOLTMETER SWITCH

In using my voltmeter switch there is no cause for anxiety about the calibration of the meter when two or three machines are thrown together for the same meter will be used for both and all machines. It is rather inexpensive to make, as the only machine parts are the two brass rings and the round fiber base on which the segments and rings are mounted. The plan view shows the connections for three generators. The three short segments can be marked No. 1, 2 and 3 generator respectively so as not to cause any confusion in reading. The two brushes are always in contact with the rings, and it is impossible for arc to carry from one short segment to another on account of their distance apart.

Linton, Ind. JOHN J. NOLAN.

Lignites and High-Moisture Fuels

Having read with much interest the article "Combustion of Lignites and High-Moisture Fuels," by T. A. Marsh, on page 525 of *Power* for Apr. 8, I would very much like to see published figures of actual tests that were made in Alberta on Alberta lignite with chain-grate stokers (Green or others) whose furnaces are the same as those shown in the illustrations of the article mentioned.

Having had much experience with chain grates in burning lignite from various parts of Alberta, I must admit that I do not consider that any of the types of furnaces shown would be very successful here. Personally I have had the best success with the arches exactly reversed, the short arch nearest the coal hopper and the long (ignition) arch extending from at or near the bridge-wall toward the short arch. This method will bring the heat farther forward and reflecting on the incoming coal as it leaves the hopper will assist greatly in driving off the moisture and in igniting the fresh coal. In this plant we were unable to burn lignite slack at all on the chain-grate stokers until we had put in arches in the way I have mentioned.

This type of arch has been adopted by the power plants at Calgary, Lethbridge, Saskatoon (Saskatchewan), and I think Moose Jaw now has them. Knowing that the principal power plants in Alberta that are operating on lignite have their arches the reverse of those shown in the article I am referring to and having found from my own experience that this was necessary, I should like to get in touch with someone who is using the type of furnace shown in the article under discussion operating on Alberta lignite, as I am ready to adopt any method by which the best results can be obtained.

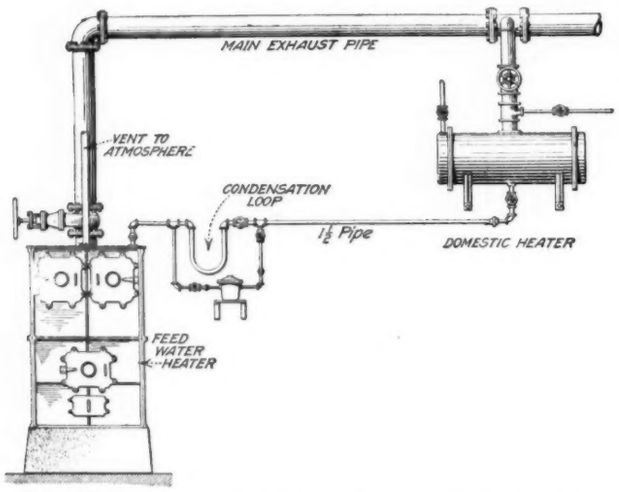
Fresh coal just deposited on the grates from the hopper will not ignite till the moisture has been driven off by the heat of the furnace and will tend to cool off the front arch until it (moisture) has been heated to a high temperature, and it stands to reason that the sooner that is done the less the front arch will be cooled and the sooner ignition will take place, so the farther forward the hot burning gases are brought by the ignition arch the greater will be the heat on the fresh coal. I would be pleased to read the views of others on this subject. C. F. COPE.

Edmonton, Canada.

No Safety Valve on Domestic Heater

The heating equipment of a large commercial and office building, as originally installed, included a small low-pressure heater, consisting essentially of a cast-iron shell containing a set of circulating coils as a supplementary source of hot water for a limited area in the building. This heater was connected between the main-engine exhaust pipe and the feed-water heater, as shown in the illustration. The loop in the pipe running to the feed-water heater served as a condensation trap to keep the steam from blowing directly through.

Eventually, the heating and electrical requirements of the building came under central-station service. Under this method of operation the engines were shut down during the summer months. It was necessary, therefore, to make a live-steam connection to the small heater in order to keep the hot-water service going during this interval. Since a high-pressure steam connection to an apparatus only strong enough to sustain ordinary exhaust pressure naturally calls for a pressure-



SHOWING PIPING OF THE DOMESTIC HEATER

reducing valve, one of these valves was installed. But it was an old valve long past its days of usefulness, and it did not work very well. The attendant might set it to get enough steam through to heat the water satisfactorily, but when he would go back after awhile to take a look no steam would be going through. He would then pick up a piece of scrap iron, a lump of coal, a monkey wrench or whatever appeared to be about right, and hang it on the regulating lever of the valve; whereupon the steam would again start simmering through. Presently there would be a great commotion inside the feed-water heater, the regulator having gradually responded to the added weight and allowed a full current of high-pressure steam to blow through. This, however, was not particularly dangerous, since the atmospheric vent from the feed-water heater was ample to keep the pressure from accumulating.

The pressure regulator got to be such a nuisance that it was discarded and an ordinary globe valve put in its place. This was not such a bad idea. The attendant could crack the valve just enough to let in the needed quantity of steam; but if through inadvertence the valve was ever opened too much, the outlet to the atmosphere would keep the pressure from rising high enough to blow up anything; and anyway the price of regulator reducing valves about that time was away up.

Eventually, the engine plant in the building was abandoned altogether, the operating company having made provision for supplying steam for heating purposes directly from a central boiler plant. Also, about this time a number of condensation meters were installed. As the abandoned feed-water heater was pressed into service as a tank for receiving the discharge from the meters, it was essential that no undue pressure be created therein, as might be the case if the drain connection from the domestic heater remained as originally installed. It was determined, therefore, to connect in a steam trap, as shown.

This arrangement worked very well while the little heater held out. But that was a distressingly short time. The heater was at an elevation about midway of a stairway that ascended near-by. As the engineer was walking up the steps one morning the inevitable happened—the little heater was blown to fragments. The engineer was badly cut and scalded as a result of the accident.

A reliable relief valve on that heater would have insured the nearest possible approach to safety. It is probable, however, that the operating company had no suitable safety valve lying around unused when they decided to bottle up the domestic heater with a high-pressure steam trap. Furthermore, if the globe valve in the steam-supply pipe was always kept adjusted just so—and it was confidently assumed that the attendant would do that very thing—there would be no need for a relief valve. At any rate there was no safety valve on the heater.

A. J. DIXON.

St. Louis, Mo.

Fumes from Oil-Engine Exhaust

Several months ago we installed a 20-hp. semi-Diesel engine, running at 235 r.p.m. The exhaust enters into a muffler tank and from there escapes to the atmosphere. No complaints were received during the cold winter months, but lately, since surrounding factories have opened their windows, protests have been coming in about the gases from the exhaust of our engine causing sickness among the help, and we have tried in various ways to remedy the matter, but so far without success.

One method tried was to carry a 4-in. exhaust pipe from the muffler tank up two stories so that the exhaust from the engine was above our roof. At times the exhaust appears to be clear and practically without fumes, and at other times the gases seem to settle near the ground, hence the cause for complaint. The extension of the exhaust pipe does not seem to have remedied matters.

We tried putting on a muffler in which water was sprayed, but the muffler was blown to pieces; probably it was too small for the pressure exerted by the exhaust gases from the engine.

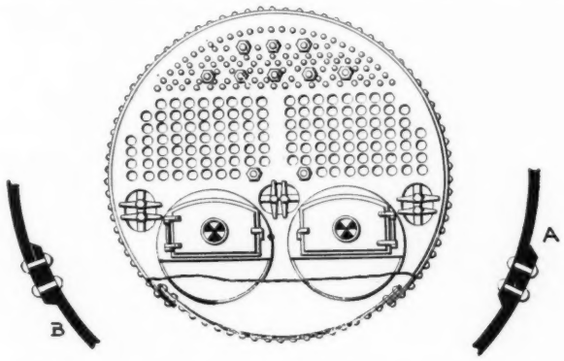
Of course, we desire to abate the nuisance to those who are located in our vicinity, and I would appreciate any information that gas engineers may have regarding the treatment of gases from the exhaust of engines. Probably some of the readers of *Power* have had experience along this line, and can give information that will be of assistance.

G. R. THOMAS.

Albany, N. Y.

Why Does One Seam Groove More Than Another?

As is well known, grooving at the longitudinal seams of lap-seam boilers has been the cause of many serious boiler explosions. As a boiler inspector, I have noticed, however, that much (I might say everything) depends on the lay of the plate at the seam. With a lap seam



SHOWING TWO TYPES OF RIVETED JOINTS

having the plates arranged as shown at *A* I have never yet found a case of grooving, whereas if arranged as shown at *B*, grooving can often be found in all stages. Why should this be? I have asked several engineers, but have had no satisfactory explanation. Can any reader answer the question? This applies to what is known as the Lancashire or Cornish boilers which are in general use in this country. The grooving is usually to be found when the seam is toward the bottom of the boiler.

A. BENNETT.

Wigan, Lancashire, England.

Losses in Belt Transmission

Comparatively little attention is given to the economic and efficient transmission of power by belt from prime movers to productive machines. There are two factors of loss in belt transmission that are equal to, if not greater than, any two factors of loss in power production; namely, excess tension and belt slip. The first is a source of lost power and increased cost of maintenance, and the second results in lost power, loss of production and increased maintenance cost.

In a well-conducted power plant a slight steam leak receives immediate attention because it advertises itself and its existence reflects discredit on the man in charge. But a much greater loss from slips or excess tension may continue indefinitely and receive no attention. In fact, its existence may not even be suspected.

The traditional practice of increasing the tension to reduce the slip does not materially reduce the loss. It simply shifts it from loss of production through slip to loss of power from excess tension. If the statement that "each 1 per cent. of slip means a loss of 1 per cent. of power" were changed to "each 1 per cent. of slip means a loss of 1 per cent. of production," a more accurate idea of the loss would be expressed. If the loss through slip is converted into a loss of time, then each 1 per cent. of slip means a loss of 1 per cent. of the operating time, and hence a loss of three days in each 300-day year. Since the loss through slip, under ordinary conditions, ranges from a minimum of 5 per cent. to more than 15 per cent., we are confronted by a minimum loss of 15 days' production each year. Thus, where operating expenses are $100 a day, a yearly tax of $1500 is paid on inefficiency and traditional belt care. Add to this the loss of power from excess tension, and the bill becomes considerably larger.

In a mill in which a fan was driven from a motor by a 4-in. double leather belt, under dusty conditions, the tension of the belt was regulated by observing the reading of the ammeter. This was kept at 22 amperes, the impression being that the efficiency of the fan depended on the power used as indicated by the meter.

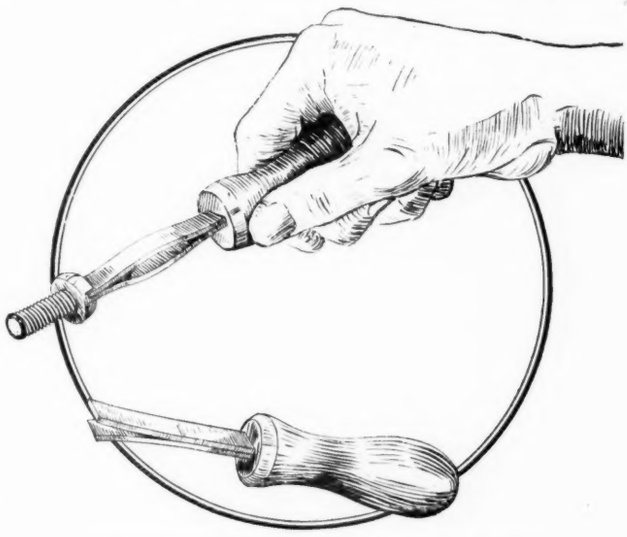
Under the direction of another superintendent tests were made which showed that with this high tension the loss through slip was from 7 to 12 per cent. The belt was thoroughly cleaned, repaired and adjusted until it was just tight enough to run steadily. The slip under these conditions was from 2 to 5 per cent., while the meter showed a steady reading of 9.1 amperes at 440 volts. Thus, more than 1.4 times the power necessary to do the work was wasted in overcoming excess friction due to high belt tension, with correspondingly high maintenance cost.

This is an extreme case, yet it existed under a superintendent who is an apostle of efficiency and an excellent executive, but who followed traditional practice to an extreme degree. When these two factors—excess tension and slip—are given the attention they deserve, transmission costs will be greatly reduced. How many superintendents know from actual tests their losses through slip and excess tension?

Tyrone, Penn. J. FRED ENGLER.

Handy Screw Holder

It is sometimes inconvenient to start a small screw into a hole when it is impossible to start it with the hand. A handy screw holder can be made by placing



SCREW HOLDER AND ITS APPLICATION

two pieces of spring steel in a handle, as shown. Then, by pressing the two open ends together and putting them in the screw slot, the tendency of the ends to open will hold the screw and it can easily be started in the hole and then tightened with the ordinary screw driver.

WILLIAM H. WATSON.

Norristown, Penn.

More Efficient Power-Plant Operation

I have been interested in the descriptions and drawings of the United States Nitrate Plant No. 2, at Muscle Shoals, Ala. The article in the May 27 issue was especially interesting as it gave the heat balance for the station and the expected economies that should prevail in future operation. The figures show remarkably low coal consumption. To actually produce these results is another matter. It will require an A-1 organization from top to bottom, and the combined teamwork must be perfect. This is where many such stations "fall down." Notwithstanding the fact that power plants are presumably designed and built to operate at maximum economy, the operation usually suffers from a lack of understanding. This is largely because the management greatly underestimates the skill required to get the best possible results obtainable.

The recent nation-wide experience in war activities has taught many valuable lessons. One of these, and a very important one, is more efficient power-plant operation. This must and will come. Some of the managers will have to shed some of their antiquated ideas. Labor costs will no doubt rise, but the final kilowatt-hour cost will go down to a point somewhere near where it should b and stay there. The final cost is the real thing.

CHARLES A. CAHILL.

Milwaukee, Wis.

Proportioning Fuel Economizers

With reference to A. B. Clark's article on "Proportioning Fuel Economizers," in the Apr. 22 issue, I heartily agree with him that the operating characteristics of economizers are destined to become of increasing interest in the near future, considering the rise in boiler pressures and boiler ratings, and also the high price of fuel.

He has, however, made use of a lengthy and not exactly accurate method of figuring results which can be obtained by shorter means. I have worked out the following formula for parallel flow and counterflow, giving relations between incoming and outgoing gas and water temperatures and heating surface:

Parallel flow,

$$S = -\frac{W c_p g}{f(1 + c_p g)} \log_e \left[\frac{T_2 (1 + c_p g) - (t_1 + c_p g T_1)}{T_1 - t_1}\right]$$

Counter flow,

$$S = -\frac{W c_p g}{f(1 - c_p g)} \log_e \left[\frac{T_2 - t_1}{c_p g (T_2 - T_1) + (T_1 - t_1)}\right]$$

in which

S = Total heating surface, sq.ft.;
W = Flow of water, lb. per hour;
T_1 = Incoming gas temperature deg. F.;
T_2 = Outgoing gas temperature deg. F.;
t_1 = Incoming water temperature deg. F.;
c_p = Specific heat of gas, B.t.u. per lb. per deg.;
g = Gas flow, lb. gas per lb. water;
f = Rate of heat transfer — B.t.u. per sq.ft. per degree difference per hour.

$\log_e$ means logarithm to base e or natural logarithm.

The negative sign may look queer, but it will be noted by use of the formula that this cancels out since the logarithm of the term in brackets is negative. Also it must be noted that the formula is based on zero radiation loss, and that the heat-transmission factor must be properly assumed with reference to velocity of gas and water flow, etc.

Using Mr. Clark's two sets of assumed conditions the formulas give the following results:

W = 100,000 lb. per hr.
T_1 = 600 deg. F.
T_2 = 340 deg. F.
t_1 = 100 deg. F.
c_p = 0.24
g = 12.25/6.3 = 1.945
f = 5.5 B.t.u. per hr. per sq.ft. per degree difference. Mr. Clark's figure, 7,500

Parallel flow
S = 8310
Mr. Clark's figure, 8,250

Counterflow
S = 7,260

Conditions same as above except—
t_1 = 150 deg. F.
g = 12.25/6.55 = 1.87

Parallel flow
S = 10,220
Mr. Clark's figure, 10,250

Counterflow
S = 8,330
Mr. Clark's figure, 8,350

The rise in water temperature may of course be obtained directly from the drop in gas temperature, specific heat of gas, and ratio of gas to water.

Lorain, Ohio. C. C. COBB, JR.

Enlightening Electrical Answers

The following answers taken from a quiz, given at one of our barracks, to a bunch of aspiring Edisons, may be of interest to your readers.

Ohm's law is a law laid down by the states to prevent electrical fires.

The safety limit of any size conduit is, fill it so that air can't circulate and cause shorts.

A bridging telephone line is one that connects three or more farmers.

A series line is one that connects less than two more than one.

Edison discovered the storage battery from a pet cat.

Kilowatts are units, the size of which are regulated by law, that come out of generators.

Transformers are instruments for making soft and pleasing lights for household use. They are not used on street lights because in that case they need a sharp penetrating light.

High-tension lines are ones that are pulled tighter than low-tension lines.

A storage battery can be charged on alternating current by reversing the leads at each cycle. (This is undoubtedly true.)

Electrolysis is the system used by undertakers for cremating bodies.

A. W. KIRBY.

Baldwin City, Kan.

Simple Trap Telltale

On asking the chief engineer of a plant I was visiting, the reason for the blowing of a small whistle, I learned something that may be of use to the readers of *Power*.

In this plant they have a return trap that is on very exacting duty. For fear that it might hang up after discharging, a whistle was attached to the trap so that it would blow when live steam was admitted. If the whistle continued to blow when the trap discharges, the man on watch knows that the trap is hung up and wasting steam. If the whistle is not heard at the regular intervals, the engineer knows there must be trouble brewing and can make an investigation before sufficient water has accumulated to do any harm.

New Bedford, Mass. H. K. WILSON.

If a shaft extends beyond the bearing housing, it should be protected by a proper covering.

Inquiries of General Interest

Splitting of Sheet at Rivet Holes of Girth Seam—What causes cracks from the rivets to the edge of the sheet in the girth seam of a horizontal return tubular boiler, immediately over the fire? H. M.

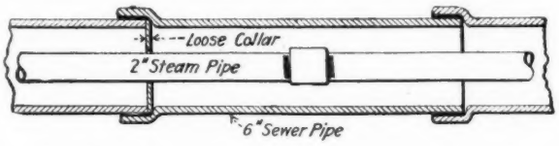
The texture of the material may have been injured in the construction of the boiler from driving drift pins or from setting the rivets too cold, but more often, splitting at the edge of the sheet is due to expansion of the rivets from becoming overheated, especially when there is scale in the boiler.

Pressure Available from Steam Line—A 2-in. steam line supplies steam to a dry room from a boiler that carries steam at 100 lb. pressure and the line is extended beyond a dry room branch to supply steam to three pumps. Is it possible for the pumps to be supplied with steam at full pressure or for the pump at the end of the line to obtain as much steam as the others? J. M.

When any steam is drawn from or condensed in a pipe line the line pressure cannot be as high as boiler pressure, because drop in pressure is a necessary accompaniment of flow or condensation. It is therefore impossible for the pumps to be supplied with steam at the full boiler pressure and the greater the draft of steam between the boiler and a branch out of the line the lower the pressure in the line at the point where that branch is taken off. When steam is supplied to any other branch, the line pressure that is available for the branch to the pump at the end of the line cannot be as great as the line pressure available to a pump or any other branch that is taken out of the line nearer the boiler.

Underground Conduit for Steam Pipe—It is desired to put down a 2-in. underground steam line about 200 ft. long for heating purposes. The pressure of steam delivered to the line will be 15 lb. What method of conduit construction is recommended where the soil is sand and clay? R. J. B.

A good conduit for 2-in. underground steam pipe can be made of 6-in. sewer pipe, as shown by the sketch. The



steam pipe is held centrally in the sewer pipe by iron washers that are like loose collars on the pipe. The outside diameter of the iron washers is the same as the outside diameter of the sewer pipe and the washers are placed at joints that are about six feet apart. The space around the steam pipe can be filled with loose insulating material or left as an air-space insulation. The top and sides of the sewer-pipe joints can be made up with cement in the usual manner, but to take care of any water that may find its way into the conduit the under side of the joints should be left unsealed with provision for the subsoil drainage.

Height of Raising Water by Return Trap—How high will a return steam trap raise water? D. M.

The height depends on the density of the water, the pressure of steam acting on the water for expelling it from the trap, the back pressure or pressure ahead of the water, and the pressure required for overcoming friction of pipes, valves and fittings. The density of water at 62 deg. F. is 62.36 lb. per cu.ft., and as a column of water at that temperature and one foot high would exert a pressure of $62.36 \div 144 = 0.433$ lb. per sq.in. for each pound pressure of steam in excess of back pressure and pressure required for overcoming friction, the water could be raised to a height of $1 \div 0.433 = 2.309$ ft. At 200 deg. F. water weighs 60.07 lb. per cu.ft., and without allowance for back pressure and pipe friction, for each pound pressure of steam acting on the surface of the water it could be raised to a height of $1 \div (60.07 \div 144)$ or $144 \div 60.07 = 2.397$ feet.

Lower Compression Due to Higher Vacuum—Why do indicator diagrams from the low-pressure cylinder of our compound condensing engine show less compression of the exhaust for 28½ than for 26 in. condenser vacuum, without change of the engine valve setting? A. H.

The absolute pressure represented by 28½ in. vacuum would be $30 - 28\frac{1}{2} = 1\frac{1}{2}$ in. mercury-column pressure, and for 26 in. vacuum would be $30 - 26 = 4$ in. mercury-column pressure. Hence, with the exhaust closing at the same fraction of stroke, compression of the exhaust with 28½ in. vacuum would be only $1\frac{1}{2} \div 4$ or $\frac{3}{8}$ as high in absolute pressure as for 26 in. vacuum.

Volts Drop in Power Line—If 250,000-circ.mil conductors were used to transmit 800 hp., having a power factor of 0.80, 8000 ft., at 2200 volts, on a three-phase 60-cycle system, with the conductors spaced in a triangle 24 in. apart, what would be the volts drop in the line? G. G.

The volts drop in a three-phase circuit may be calculated in the same way as for a single-phase circuit transmitting one-half the load. Therefore, in this problem, find one-half the three-phase load in amperes and proceed as if calculating a single-phase circuit. One half the single-phase watt W = hp. $\times$ 746 $\div$ 2 = 800 $\times$ 746 $\div$ 2 = 298,400 and the current I.

$$I = \frac{W}{E \times P.\ F.} = \frac{298,400}{2200 \times 0.80} = 170 \text{ amperes.}$$

The volts drop in the circuit is made up of two parts, one the resistance component and another the reactance component. If E_R is let to represent the volts drop due to the resistance of the conductors and E_X the volts drop due to the reactance of the circuit, we have

$$E_R = \frac{2LIR}{1000}$$

Where L equals length of conductors in feet one way and the R resistance per 1000 ft. of conductor; and

$$E_X = \frac{2LIX}{1000}$$

where X equals the reactance drop in volts per ampere per 1000 ft. of conductor at 60 cycles, conductors spaced 24 in. apart; as obtained from a table $X = 0.110$. Then

$$E_R = \frac{2 \times 8000 \times 170 \times 0.042}{1000} = 114.24 \text{ volts}$$

and

$$E_X = \frac{2 \times 8000 \times 170 \times 0.110}{1000} = 299.2 \text{ volts}$$

The volts drop in the line is

$$E_d = \sqrt{E_R^2 + E_X^2} = \sqrt{114.24^2 + 299.2^2} = 320.3 \text{ volts}$$

This is equivalent to $320.3 \div 2200 = 14.55$ per cent. drop, which is considerably higher than would be considered good practice.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Combination Internal-Combustion and Steam Engine of High Efficiency

In a paper read recently before the Royal Society of Arts (England) and abstracted here, Frank E. D. Acland described a combination internal-combustion and steam engine developed by W. J. Still, in which the products of combustion act on one side of the piston and steam on the other, the steam being generated largely by the waste heat from the gas cycle.

THE maximum ideal efficiency of a heat engine is obtained where the difference existing between the highest and lowest temperatures of the working fluid is greatest in proportion to the maximum temperature, and here the ordinary internal-combustion engine, with an initial temperature often higher than the furnace temperature of the boiler is capable of realizing better thermal conditions than any other form of heat engine; but in its turn it suffers from two disadvantages—it ejects its working fluid at a temperature too high for ideal conditions, and it loses heat energy to a regrettable extent in the cooling of its cylinder. In existing engines some proportion of the heat can be usefully recovered as steam from the exhaust gases, but the cooling water from the jacket is of little value, owing to its low temperature, and the efficiency of the engine itself is not augmented. If, however, the temperature of the cooling water could be maintained at that of steam at useful pressure, the efficiency of the engine would be improved and the weight of steam be usefully increased. This is accomplished in the engine developed by W. J. Still.

The Still engine is an engine capable of using in its main working cylinder, any form of liquid or gaseous fuel hitherto employed; it makes use of the recoverable heat which passes through the surfaces of the combustion cylinder, as well as into the exhaust gases, for the evaporation of steam, which steam is expanded in the combustion cylinder itself on one side of the main piston, the combustion stroke acting on the other side. It increases the power of the engine and reduces the consumption of the fuel per horsepower developed.

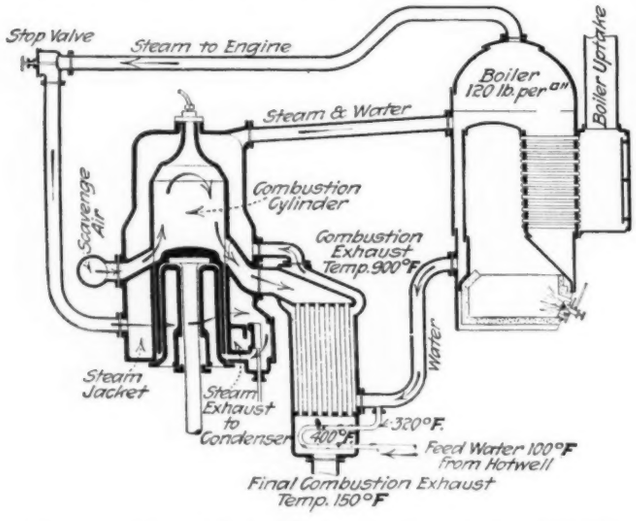


FIG. 1. CROSS-SECTION DIAGRAM OF STILL ENGINE

Its primary object is not to use the waste heat for raising steam, but first to use it in improving the thermal conditions of the working cylinder, and so insure the maximum efficiency from the fuel burnt within it, diminishing, as a consequence, the heat lost in that operation. Since the maximum efficiency is obtained by combustion of the fuel in the cylinder and the minimum by the evaporation of the water in the steam generator, it is evident that the larger the quantity of steam that can be generated per horsepower developed by the combustion cycle, the lower must be the heat efficiency of the whole machine.

In the Still engine (Fig. 1) the jacket and cooling water form part of the circulating system of a steam generator, which may be an integral part of the engine or external to it. The cooling water therefore enters and leaves the jacket at a constant temperature, regulated by the pressure of steam, the cooling being effected by converting the water into steam without raising its temperature. Excluding the radiation losses, which are kept low by lagging, all the heat which passes through the walls is thus usefully recovered in the water as steam. The temperature of the cylinder wall is uniform over the whole of its exterior surface, and the heat lost to the cooling water at each stage of the cycle—compression, combustion and expansion—is diminished.

During compression, owing to the walls being at steam temperature, the incoming charge picks up heat, instead of losing it, during the greater part of the stroke, an advantage of the greatest value to the heavy-oil types of Still engines, where an air charge is taken in at the full outstroke, and is compressed to a pressure where its increased temperature insures the certain ignition and combustion of the fuel that is injected into it.

During combustion and expansion the uniform and higher mean temperature of the walls reduces the heat lost to the jacket water. Some of the heat thus economized adds to the useful work on the piston, the rest passing out in the exhaust gases for recovery.

To insure the maintenance, in a practical and reliable manner, of the temperature conditions that produce this efficiency during the combustion cycle, a departure from the design and construction of the cylinders of normal internal-combustion engines is imperative; they have hitherto been made of cast iron, of a thickness sufficient to resist the working and thermal stresses thrown upon them, including occasional heavy loads caused by preignition of the explosive charge. With these thick walls or liners, the temperature difference between their inner and outer surfaces, which is essential if the surplus heat is to be carried off, can be obtained safely only by the circulation of water at low temperature through the jacket; this is especially the case in cylinders of considerable diameter or capable of high power per swept volume.

The cylinder of a Still engine consists of an inner liner, which is approximately one-third to one-fourth the usual thickness; it is ribbed externally so as to add to its conducting surface and provide suitable passage for the cooling water, and it is reinforced by an outer hoop capable of withstanding the highest pressures to be met with in working. The stresses due, in ordinary practice, to the cold water at the inlet, and the hotter water at the outlet, are suppressed in the Still cylinder, the cooling water being at a controlled and uniform temperature throughout.

Steam from Waste Heat

In gas and oil engines of constant-volume and constant-pressure types the combined losses in radiation—cooling water and exhaust gases—range between 75 per cent. and 65 per cent. The highest indicated thermal efficiency claimed under test conditions with a Diesel engine (Mathot) 300 b.hp., four-stroke at three-quarter load, is 47 per cent. (36 per cent. brake efficiency). If 4 per cent. is allowed for radiation, 49 per cent. of the total heat is available for recovery, and if 10 per cent. efficiency is assumed for the steam cycle, the brake thermal efficiency of an engine giving this high result would be raised by 10 per cent. of 49 = 4.9;

that is, 36 + 4.9 = 41 per cent.; but there is no reason why the steam generated and used under the conditions of the Still system should be limited to so low a figure. Fifteen per cent., according to the author, seems a more reasonable assumption, and even a higher figure may be anticipated, in which case a brake thermal efficiency of 44 per cent. should be possible in a complete installation.

The exhaust gases take a subsidiary but important part in the cycle; their usefulness in ordinary combustion engines, in raising steam, is limited to the amount of heat recoverable between the initial temperature of the exhaust and that of, say, 50° F. above the steam temperature, after which the whole volume passes away to atmosphere at a still useful temperature, less a small percentage available for feed-water heating. But in the Still engine, the

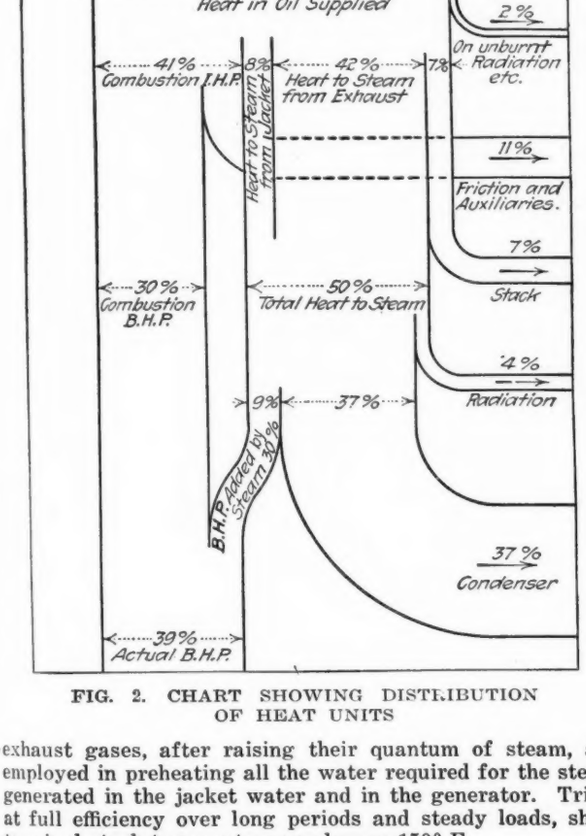


FIG. 2. CHART SHOWING DISTRIBUTION OF HEAT UNITS

exhaust gases, after raising their quantum of steam, are employed in preheating all the water required for the steam generated in the jacket water and in the generator. Trials at full efficiency over long periods and steady loads, show terminal stack temperatures as low as 150° F.

The piston and cylinder walls, preheated by the combustion stroke, are at a higher temperature than the steam when it is admitted and while it is being expanded; there is, therefore, no loss from condensation, and the steam exhausts at a slight superheat above the normal expansion temperature, a condition which is unattainable in any form of steam engine without direct loss of energy. With an early cut off, it can be expanded economically right out to atmospheric pressure, or below it, and be either recompressed (Stumpf cycle) or exhausted to the condenser. The steam, during expansion, forms an efficient means of cooling the piston.

The Still oil engine starts with the cylinders and pistons preheated. The air charge, from the moment of its entry into the cylinder, picks up heat from the containing walls and continues to do so during at least 70 per cent. of the compression stroke, with the result that the temperature necessary for firing with certainty the first injected charge of fuel is reached with a compression pressure 50 per cent. less than that required in a Diesel engine.

This fact is far reaching in its importance, for it gives to the designer great elasticity and freedom of application; for a Still heavy-oil engine can be designed for constant pressure or constant volume, or both can be employed in the same engine by correct timing of the fuel injection. It claims for its combustion cycle an efficiency higher than that of the Diesel, less weight and space per horsepower, and for its combined cycle an efficiency not less than 20 per cent. higher than any prime mover which uses fuel as its source of heat.

Normal Load—The average m.e.p. from the combustion stroke was 90 lb. per sq.in. The steam evaporated by the "waste heat" gave 14 lb. per sq.in. m.e.p. on every return stroke. This is equivalent to 90 + 28 = 118 lb. per sq.in. m.e.p. in a normal four-stroke engine.

Overload—By admitting additional steam generated by fuel under the boiler, the steam m.e.p. was raised to 72 lb. per sq.in.; the total m.e.p. was, therefore, equal to 90 + 144 = 234 lb. per sq.in. m.e.p. in a normal four-stroke engine.

Business Training Recommended for Engineers

At the call of the Commissioner of Education, a two-day conference was held in Washington, June 23-24, and was attended by over 150 educators, representatives of engineering firms and prominent engineers. The concensus of opinion was expressed in resolutions passed at the final session favoring the addition to engineering curricula of courses in general economics, cost accounting and business law and urging that the economic phases of engineering subjects be emphasized in commercial instruction, and that the institutions that have departments of engineering and economics or commerce be urged to consider some plan of coördination to develop a course to prepare candidates to meet the demand for large numbers of technically trained men for both foreign and domestic commerce.

At the first session, Dean Anson Marston, of Iowa State College, led the discussion on business training for the engineer. Spencer Miller, vice president of the American Society of Mechanical Engineers and of the Lidgerwood Manufacturing Co., New York, placed first the need for developing character and outlined the qualities needed in engineering salesmen and the golden opportunities awaiting them. In the discussion was pointed out the danger of attracting too many men from the fields of design and research work, and the fact that it would be a mistake for all colleges to begin to train business engineers. Prof. G. H. Follows, of the department of commercial engineering at Carnegie Institute of Technology, Pittsburgh, outlined the course by chart and declared that a complete commercial training filled a four-year course, it being almost impossible for men who had taken ordinary engineering courses to become managers of men. It was stated that the reorganization plans at Harvard and Yale universities contemplate such specialization in the fifth year as graduate work.

Engineering Training for Commercial Enterprises

Prof. Walter Rautenstrauch, of Columbia University, in discussing engineering training for commercial enterprises, insisted that no worthwhile instruction could be given without highly paid teachers. A department of manufacturing is contemplated at Columbia as a six-year course. E. F. Dubrul, president of the Pyro Clay Products Co., Cincinnati, claimed that the science of business was as broad and its ethics as high as any profession, and that executives are highly paid because they control both the engineering production and the commercial or distribution phases of industry. Money will be provided by business men if the educator will show willingness to adopt new methods for supplying the kind of graduate they need—the course to be devised in conference. He called attention to the new college of engineering and commerce at the University of Cincinnati as offering a coöperative course of large promise. In the discussion a Colorado executive was cited as authority for warning against too many business engineers, claiming fifty technical men were needed to one executive.

The third session was devoted to the significance of the war experience for engineering education, a paper by Maj. Gen. John F. O'Ryan, of New York, being read by Mr.

Swiggett. He pointed out the shortcomings of the present educational system in character training and suggested as a remedy the inclusion of nonsectarian moral law developed and applied by courses of psychology, leadership, responsibility and physical training. He urged a scientific program for developing professional character.

Dr. Charles R. Mann, chairman of the Advisory Board, Committee on Education and Special Training of the War Department, pointed out that both army men and practicing engineers place character first. He raised the question as to just what is meant by the "fundamentals" which so many advocate, and claimed that these fundamentals are at once apparent if the army method of beginning with a definite job asking what the engineer has to do, is followed. Thus the motive is developed, and results follow because the student is doing something definite and learns to think on the job. Morale is a dominant factor, better than character as a test, and he would judge classwork by group morale. The teacher should be a friendly investigator trying to lead the student to his best attainments rather than one who merely tries to meet certain set standards—and generally failing in a large proportion. The classification and rating system of the army should be applied—helping to measure accomplishments. The chairman, Maj. Gen. W. M. Black, Chief of Engineers, U. S. Army, advocated less individualism and the development of more coördination; also training for self-mastering through the subordination of passion to duty. He deplored over-specialization and suggested that engineering degrees should be withheld until after practice in actual engineering work had really qualified the graduate as an engineer.

Training for Overseas Engineers

At the last session, on Training for Overseas Engineering Projects, A. W. McLean, director of the War Finance Corporation, Washington, as chairman, emphasized the need for financing foreign investments, and for this country to assume to lead in foreign fields, claiming that engineers and business men can take the position of leadership if they have the courage and enterprise. C. H. Gardner, of the American International Corporation, New York, advocated more training in vision to see opportunities, especially in transportation, saying that the engineer should be the pioneer. He would have French and Latin required for college entrance. W. W. Nichols, chairman of the American Manufacturers' Export Association's Committee on Education, pointed out that industry and engineering are mutually dependent, that pure engineering belongs only to rare genius, and that the rank and file of engineers need a practical training. Foreign languages should be taught to develop knowledge of customs and mental attitude of the foreign peoples.

Dr. Jeremiah W. Jenks, research professor, government and public administration, New York University, in an illuminating address, showed two kinds of problems—to get trained men at once for overseas service and to develop such men for holding future supremacy in foreign trade. He classed commerce as one of the humanities, on a par with history and economics. Credit should be furnished in foreign fields, but only by controlling stock interests in order to insure wise and successful management. The discussion by men in industrial concerns interested in foreign fields, developed the necessity for long-time credits and for using ingenuity to find men with language qualifications and also sufficient technical knowledge to represent them abroad.

The Present Condition of Research in the United States *

Research work, quite general before the present war, became more extensive in overcoming the dastardly appliances of the Hun in devising new apparatus, products and manufacturing methods and in improving quality and production. The war has demonstrated, if demonstration is necessary, the value of research, and it is now the opinion of most of us that this stimulating viewpoint should not be lost and that wartime interest should be continued. For this reason it is well to consider the present condition of research in this country.

The cost of research in the past has been such that in many cases it could be undertaken only in an extensive way by large corporations. The necessity and value have been evident, but the small plant has been unable to inaugurate that which is known to be of value. However, the necessity for such work has been clearly seen and appreciated by some, and in this country institutions and foundations such as the Rockefeller Institute, the Carnegie Institution and the Sage Foundation are carrying on investigations and giving grants to those who are working on problems for the general good. Investigations have also been undertaken by an industry as a whole or by a group of manufacturers, and the results have been distributed among the contributors to the expense funds or, in some cases, freely given to the world. Various states have for over thirty years been conducting agricultural experiment stations for the benefit of the farmer. This field of research is rapidly widening. Engineering-experiment stations for the benefit of the farmer. This benefit of the manufacturers.

The equipment of technical schools is usually quite diversified and well adapted to research work. The lack of time for exhaustive experimentation, however, in schools of this kind is due largely to heavy schedules of instruction work. Nevertheless, some work of great value has been produced in technical schools by faculty members, graduate students and even by undergraduates.

Many engineering problems have been solved by the aid of university experiment stations, of which there are at present some fifteen in different colleges in this country; for instance, a coöperative plan of equipping a full size rolling mill at Carnegie Institute of Technology with special apparatus for research work definitely associated with the steel industry.

The government activities in research have greatly expanded since war was declared. At the Bureau of Standards research work in physics, chemistry, metallurgy, manufacturing and engineering has been done. There is hardly a branch of human endeavor that is not touched by this enormous research laboratory. Other government research work is carried on at the United States Naval Experiment station at Annapolis, the Forest Products Laboratory at Madison, Wis., the Watertown Arsenal, and the Philadelphia Navy Yard.

One of the great needs of the present time is that for more research men. Research demands a man of clear vision, great imagination, tremendous resources, absolute honesty, good training and devotion to work. The love of the work will have to be the incentive in many cases, as the monetary returns are small. The field of research is broader than ever, and if our colleges of engineering and science could by some means instill into more men the great desire for discovery through research, they would aid much in the contribution of this age to the welfare of the future.

*From report presented at the Spring Meeting of The American Society of Mechanical Engineers, Detroit, Mich., June 16-19, 1919.

Annex to Cleveland Municipal Plant

According to the Cleveland *Plain Dealer*, the $2,000,000 addition to the Cleveland, Ohio, municipal electric-light plant will be in operation early in July.

At the start the plant will have sufficient power to furnish energy to 14,000 consumers at prices ranging from 3c. a kilowatt in residences to 1¼c. in factories.

Additional generators will be installed later, and six times as many patrons will be supplied then. The new plant means cheaper current to thousands, as private companies charge from 10c. a kilowatt in residences to 1¼c. to large industrial consumers.

When all generators are in operation in the new plant the generating capacity of the combined establishments will be 76,000 kw. and it will be one of the largest public light plants in the world, according to Mr. Beckwith, superintendent of heat and light.

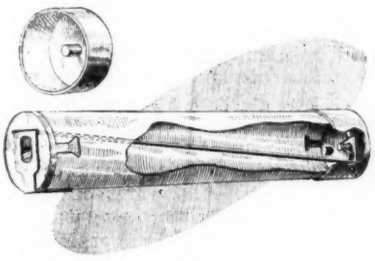
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Fuse, Refillable

Volk Distributors, New York City

"Power," Apr. 22, 1919

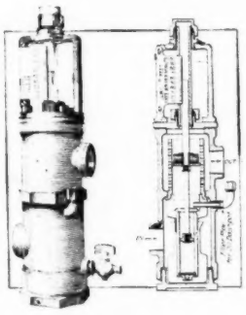


This refillable fuse is made up of a fiber shell closed at each end by metal disks and held by two dovetails that pass through the shell. The fuse element is in strips of standard form and passed through slots in the metal disk at each end of the shell. After placing the fuse element through the shell, the ends are bent over and the ferrules screwed on, making a contact between the ferrules and the fuse element. The fuse has but two removable parts and is made up to 60-ampere capacity. In sizes above 60-ampere capacity knife terminals are used.

Tool-om-eter, New Jersey Air

New Jersey Meter Co., Plainfield, N. J.

"Power," May 6, 1919

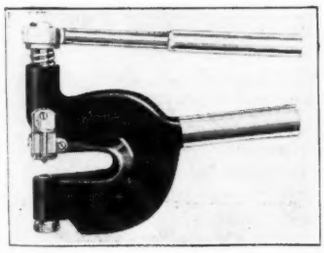


This meter shows direct on a scale, in cubic feet of free air a minute, the flow of air in pipes, etc. It operates with a small head or difference of pressure, established between the interior of the cylinder and the outlet chamber, the pressure difference being fixed by the exact weight of the moving elements and the area of the piston on which the difference of pressure acts. The meter has but one moving part, which is practically frictionless and nonwearing.

Punch, New Jiffy

Paul W. Koch & Co., 19 South Wells St., Chicago, Ill.

"Power,"



A compact portable punch weighing 5 lb. and 9½ in. long for tool kit or shop. Will punch 3/32-, 1/8-, 5/32- and 1/4-in. holes in metal up to No. 10 gage. Has disappearing stripper, giving clear view of punch and punch mark for next operation. Several sheets may be punched in one operation. Although designed for hand use, the punch may be clamped in a vise.

Coupling, "Karge" Cushion and Flexible

Three Rivers Machine Tool and Die Corporation, Phoenix, N. Y.

"Power," Apr. 22, 1919

This coupling is designed to take the place of flexible joints, gears, pulleys, belts and other mechanical devices used for the transmission of power. The coupling resembles a helical spring, and the coupling member is shrunk in the sleeve at each end. When applied to a shafting it can be bent and placed at almost any angle and will absorb shock and strain. Allowance is provided for the contraction and expansion of the spring lengthwise. The coupling is made of cast iron and the compression sleeves of steel. It is made in various sizes for shafting from ½ to 6 in. in diameter.

Cup, New Standard Grease

New Standard Manufacturing Co., 1325 Arch St., Philadelphia, Penn.

"Power," May 13, 1919

The body of this grease cup is made of brass and glass, the glass container being held in place by a double lock bail. A plunger under spring tension forces the grease out of the shank of the cup, the feeds being regulated by the tension of the spring and by the regulation of a screw in the shank. Three tensions of the spring are obtainable. A signal arrangement shows when the cup is feeding. It is refilled by unclamping the double lock bail. The capacity of the cup is 3 ounces.

Pyrometer, Brown Boiler-Room Signaling

Brown Instrument Co., Philadelphia, Penn.

"Power," Apr. 29, 1919

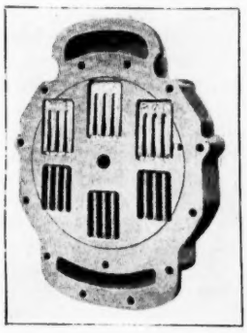
This device is designed to indicate the boiler operations when the temperature is too high or too low. Three lights are provided for each furnace—a green light indicating that the temperature is too low; white, that the proper temperature is being maintained; and red, that the temperature is too high. A contact table, adjustable throughout the whole scale range, carries three contacts corresponding to the three lights, the central contact operating the white light and covering a space usually of 20 deg. on the scale, amounting to 10 deg. plus or minus the desired temperature. The pointer of the pyrometer is automatically depressed once a minute on tungsten contacts.

Plate Valves for Sullivan Straight-Line Compressors

Sullivan Machinery Co., Chicago, Ill.

"Power," Apr. 1, 1919

Improved compressor valves designed to secure rapidity of action, wide port openings with minimum wiredrawing effect and a reduction in the power required to operate them. The finger valve is of the grid form, shaped like a group of thin flat fingers or blades and made of sheet spring steel. It is bolted at one end only to a steel guard plate, the other end being free. The guard plate is curved to form a rest for the length of each blade, when it is bent or lifted by the incoming or outgoing air.



Superheater, Dravo

Superheater and Engineering Co., 233 Broadway, New York City.

"Power," May 13, 1919

This superheater is designed for use with various types of water-tube boilers and with return-tubular boilers. Steam is agitated as it passes through the apparatus and is thus brought into direct contact with the hot surface of the tube, tending to produce a uniform degree of superheat. The superheater conforms to the code covering the apparatus, as adopted by the American Society of Mechanical Engineers. The headers are of cast steel; tubes, seamless drawn steel. The superheater can be built in sections.

Patented Aug. 20, 1918

"The Engineer in Public Affairs" Discussed in Chicago

In various engineering societies there has been a great deal of talk recently about engineers taking a more active part in public affairs and particularly in matters of engineering interest. With the Western Society of Engineers the movement has developed to such an extent that there is now a committee on public affairs, and this committee has arranged joint meetings with the City Club, of Chicago, for the discussion of various civic problems of pressing need. The engineer is given an excellent opportunity to become informed and to give out reliable information on the engineering phases of the question. It is then up to him to discharge his duties as a loyal citizen.

The second meeting of the kind followed a 12 o'clock luncheon at the club on Tuesday, June 24. The topic was "How Can the Smoke Nuisance be Eliminated in Chicago?" Joseph Harrington, formerly administrative engineer for Illinois, of the United States Fuel Administration, was the first speaker. He divided the problem into three parts—legal, social and engineering. The legal situation was good, it being a question more of the enforcement of the present ordinance rather than the need for passage of new laws.

Regarding the social phase, relating to health, general cleanliness, injury to property, etc., conditions were almost as bad as they had been before any attempt had been made to abate the smoke nuisance. It was a pity that conditions had been allowed to get into such a state, and it was essential that something should be done.

As to the engineering division of the subject, engineers were generally agreed that smokeless combustion of Illinois coal could be accomplished. A smoky plant was a reflection on the engineer who designed it or on the engineer who was operating the plant. Cleaning up Chicago would effect a practical economy. The engineers knew what was wrong and in the engineering sense what remedy to apply. The whole question was more a civic problem of public sentiment than engineering.

What Is Needed to Clean Up Chicago

Some of the requirements were a chief smoke inspector who is a combustion engineer, a good executive who can meet representative men of the city and a man who can go into the boiler room and discuss combustion problems with the engineer. For such a man the present salary was too low. It should be increased to a figure commensurate with the qualifications required.

At one time there had been a smoke commission composed of business men of high standing, which got things done that could not have been accomplished in any other way. Mr. Harrington was of the opinion that this commission should be revived. It should be composed of representative business men and should include an attorney, two engineers of high standing to give advice on engineering matters and representatives of the press and of financial interests. The press was required, as the success of the present movement ultimately hinged on the ability to create a demand for the things under discussion. Showing up offenders in the press and giving credit to those doing good work would also have an important bearing on compliance with the smoke ordinance.

Where it was necessary to remodel a plant in order to effect smokeless conditions, there were frequent cases in which owners could not afford to make the changes. If the engineers on the commission found that certain changes were necessary, and the attorney made sure that the credit of the owner was good, it would be a business proposition for the banks to advance sufficient funds to pay for the work. The saving would eventually pay for the new equipment. All that was needed was time and it was a question of allowing the banks to "hold the bag."

Education was really the groundwork of the whole movement. Upon proper publicity will depend the growth of public sentiment, which is the motive power in this case. There were two or three live engineering societies in the city that would be glad to coöperate to the utmost in any effort made by the City Club.

Summarizing, the speaker said there was need for a high-grade smoke department and a high-grade chief inspector, backed up by a representative commission, the movement to be supported by the City Club and other associations capable of waging a strong campaign of education.

Harold Almert, who also had been with the Fuel Administration, talked on the domestic side of the question. Of the millions of tons of soft coal shipped into the Chicago switching district, 85 per cent. was burned in industrial plants and 15 per cent. by domestic users. It was this 15 per cent. that caused most of the trouble, as it was resonsible for 70 per cent. of the smoke. The speaker outlined briefly how conditions in domestic heating plants could be improved. The kitchen range was the worst offender and next in order was the hot-water heater owing to the low temperatures in the flame passages and the continuous operation 24 hours per day every day in the year. The heater can be fired smokelessly by leaving the door open ten to fifteen minutes to provide enough air to burn the volatile while the coal is coking. Most of the trouble is due to visiting janitors who rush in and out and make no effort to secure smokeless combustion. Of the larger installations, 95 per cent. were designed for soft coal. There was an abundance of fuel in Illinois suitable for domestic use and there was no occasion to use coal from the East. By using the coking or alternate method of firing, there would be no trouble from smoke.

Creation of a desire for civic cleanliness should be the first step in the program. It would mean a saving to the city of $75,000,000 per year, due to less painting and cleaning of buildings, clothes and other factors aggravated by smoky condition existing at present. Outside of this there was the question of the betterment of health.

Frank A. Chambers, acting chief smoke inspector, who was to have addressed the meeting, was unable to attend. No specific action was taken at the meeting, but it was hoped that developments would come later.

Canadian Association of Stationary Engineers' Convention

The thirtieth annual convention of the Canadian Association of Stationary Engineers was held at Brantford, Ont., June 23 to 26 inclusive, with headquarters at the Kerby House.

The main hall of the Tabernacle, situated within walking distance of the headquarters, was tastefully decorated and conveniently arranged for the use of the Canadian Exhibitors' Association in the display of power-plant equipment and accessories. Forty-six firms in the engineering supply field occupied booths. The exhibit was liberally patronized during the four days.

The several sessions of the delegates were held in a hall adjoining the exhibit. Many of the engineers were prevented attending this year because of railroad strikes in a number of the Canadian cities. A large number of subjects of significant value to the organization were brought forward, discussed and acted upon. The engineers of the Dominion of Canada are graded into first, second and third classes, with interchangeable certificates, according to ability. All the local lodges will make an urgent educational campaign the coming season, with the object of promoting those engineers holding other than first-class certificates.

The opening ceremonies took place on Tuesday morning, with Charles Walker, president of the Brantford lodge, occupying the chair. D. L. Webster, chairman of the Convention Committee, welcomed the delegates and guests to Brantford. William Cook, of Belleville, president of the Canadian Association of Stationary Engineers, responded. C. N. Schrag, of Toronto, president of the Canadian Exhibitors' Association, spoke of the pleasure it gave the members of his association to be with the engineers, and hoped that the delegates would be pleased with the display. Lieut. Lloyd Archibald, past president of the Ex-

hibitors' Association, gave a short talk on his experiences as a German prisoner. Fred W. Raven, of Chicago, secretary of the N. A. S. E., spoke at length on the benefit of the social and educational features of the organization. C. Z. Wyse, G. C. Keith and George Moll also made interesting addresses, and Bob Jones, of the France Packing Co., sang tenor solos.

On Monday evening a lecture on "Heating by Steam" was given by E. T. Flanagan, of the C. A. Dunham Co., of Toronto, which was followed by a paper on "Refrigeration" by I. J. Tait, of Montreal.

On Tuesday afternoon visits were made to some of the Brantford factories.

On Tuesday evening a smoker was held in the Tabernacle. C. J. Porter, of Hamilton, gave an interesting illustrated lecture on generators. Fred W. Raven read a paper on good fellowship. H. D. Maclochlan, of the Department of Technical Education of Ontario, invited the members of the C. A. S. E. to take part in the evening educational schools of the government. He said there were 41 of these schools, and he hoped the engineers would take advantage of the offer. At the close of Mr. Maclochlan's address the engineers decided to coöperate with the government in its efforts, and requested the speaker to convey the thanks of the organization to the department. D. M. Medcalf, chief boiler inspector for Ontario, gave an address on the causes of boiler failure, and showed parts of several boilers that had failed. Jack Armour, of *Power*, entertained. Good things to smoke were furnished.

The Exhibitors Entertain the Convention on Wednesday Afternoon

On Wednesday afternoon the exhibitors entertained the convention at the armory. This event was to have been a picnic at Mohawk Park, but the inclement weather forced the picknickers into the spacious armory. Sports of all kinds for men, women and children were indulged in, including hockey and baseball with prizes for the first and second in each event. Refreshments were abundantly served, and notwithstanding the rainy day a pleasant afternoon was spent.

On Wednesday evening the biggest attendance of the convention took seats in the Tabernacle to listen to the entertainment. After the distribution of prizes to the winners in the afternoon events, an enjoyable program was furnished by the following: E. B. Curzon, baritone solo; Miss Emily Powell, soprano solo; Miss Emma Jackson, reading; C. B. Turner conducted a sale of curios for the benefit of the Brantford General Hospital; E. F. Hetherington, ballads; Bob Jones, tenor solos, and Jack Armour in stories and recitals. The performance closed with a prize drawing contest after which an illustrated lecture on turbines was given by J. M. Brown, of Hamilton.

On Thursday evening there was a reception and ball at the Masonic Temple, which proved a success in every way. The grand march was led by C. B. Turner.

At the final meeting of the delegates the following grand officers were elected and installed: William Cook, Belleville, past president; George Moll, London, president; I. J. Tait, Montreal, first vice president; Daniel L. Webster, Brantford, second vice president; Frederick Harper, Kingston, third vice president; John Hale, Hamilton, secretary-treasurer; R. C. Leach, Toronto, conductor; George Lee, Ottawa, doorkeeper. Delegates to the N. A. S. E. convention at Huntington, W. Va., William Cook.

At the meeting of the exhibtors on Thursday morning the following officers were elected: James Mock, Montreal, president; J. J. Fitzgerald, Montreal, first vice president; Grant Cole, Toronto, second vice president; Lloyd Archibald, Toronto, treasurer; George N. Wilkinson, Philadelphia, assistant secretary; Arthur Betton, Edward Hanson, Howard Fletcher, exhibit committee; W. R. Sexton, Harrold Burbridge, H. W. Cockfield, reception committee; Edward B. Curzon, J. Thompson, Earl Gordon, entertainment committee.

It was decided to hold the next convention at Woodstock, Ont., in June, 1920.

Engineering Council Notes

Contributed by M. O. Leighton, Chairman
National Service Committee

Far-reaching changes in the executive machinery of the Federal Government were proposed recently in bills introduced in each house of Congress. The Department of the Interior will become the Department of Public Works if the legislation proposed is enacted. The main idea is to assemble all engineering activities of the Government in one department.

Such bureaus of the Interior Department as are non-engineering in character are to be placed under the jurisdiction of appropriate departments, while engineering bureaus from other departments are to be included in the Department of Public Works. The bill proposes that the Patent Office is to be removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Department of the Treasury. The Bureau of Education goes to the Labor Department. The Bureau of Indian Affairs also is transferred to the Department of Labor, with the proviso that the engineering and construction work and the land and mineral surveys now performed under the direction of the Bureau of Indian Affairs are to be prosecuted under the Department of Public Works. St. Elizabeth's Hospital and the Freedman's Hospital in this city are assigned to the Treasury Department. Columbia Institution for the Deaf and the Howard University go to the Bureau of Education, under the provisions of the bill.

On the other hand, the Department of Public Works is slated to absorb the Supervising Architect's Office of the Treasury Department; the Construction Division, River and Harbor Improvements, Mississippi River Commission, and California Débris Commission of the War Department; the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce; the Bureau of Public Roads and also the Forest Service of the Department of Agriculture.

The bill provides that the Secretary of Public Works "shall by training and experience be qualified to administer the affairs of the department and to evaluate the technical principles and operations involved in the work thereof." The measure excepts from the foregoing provision the Cabinet officer who is at the head of the department at the time of the passage of the bill.

Four assistant secretaries, each to be paid $7500 per annum, are provided and their duties outlined. One is to have administrative jurisdiction over all matters of engineering design and construction. Another is to have charge of architectural design and construction. The third is to have jurisdiction over all scientific work and surveys, while the fourth is to be in immediate charge of all land and legal matters. The assistant secretaries are charged with the duty of coördinating and bringing into efficient relationship all the activities of the department so that it may be harmoniously and efficiently administered.

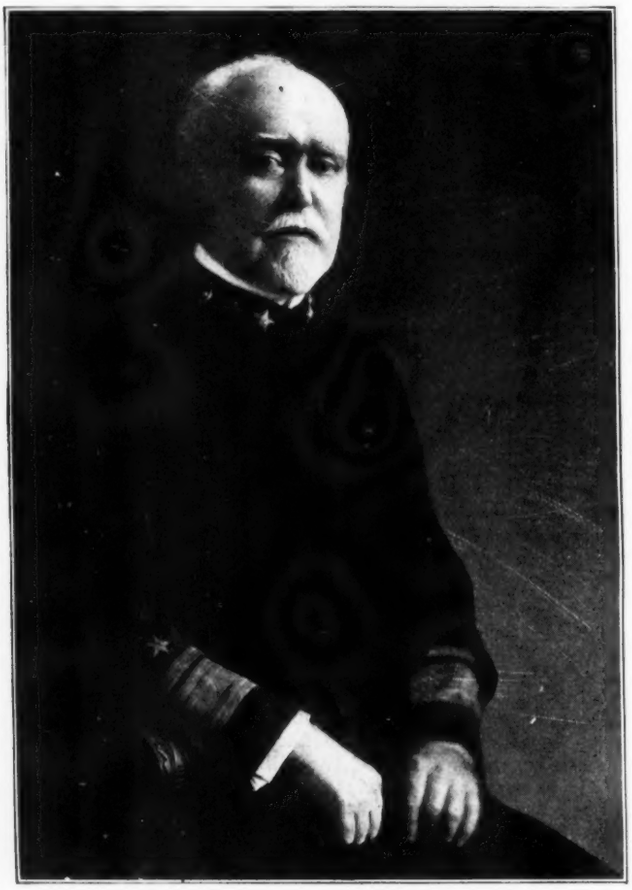
An important feature of the bill is the proviso that engineer officers of the United States Army detailed on non-military work are to be assigned by the Secretary of War to like duties under the new department for not over two years. This enables the Secretary of Public Works to make gradual transfer of improvements and instrumentalities to civil administration without detriment to public interest. Members of the Corps of Engineers may, under the direction of the Secretary of Public Works, be detailed by the Secretary of War to temporary duty in the new department for such instruction, training and experience as is desired.

Four hundred and eighty-five locomotives sent abroad for the use of the American army have been sold to the French government. Two hundred and twelve engines and 12,404 cars remain to be sold.

Admiral Griffin Receives Honorary Degree

The honorary degree of Doctor of Engineering was conferred upon Rear Admiral Robert S. Griffin, engineer-in-chief of the United States Navy, by the Stevens Institute of Technology of Hoboken, N. J., on June 17. While comparatively few, outside of those intimately connected with naval engineering affairs, are aware of the vast scope of his activities, and especially the responsibilities carried during the period of the war, it will be a source of gratification to his friends and associates to learn of this richly deserved honor.

The new navy may be considered as commencing with the Roach cruiser about 1885, at which time Admiral Griffin was an inspector of machinery for those vessels. From that time down to the present, except for tours of sea duty,



ADMIRAL ROBERT S. GRIFFIN

he has had an active and responsible part in the equipment efficiency of our naval vessels.

Admiral Griffin, for more than five years, was the assistant of the late Admiral George W. Melville, engineer-in-chief of the navy, and in 1913 was appointed chief of the bureau. The efficiency of his administration has been so great that when the four-year detail had expired in 1917 the Secretary of the Navy, contrary to precedent, continued him as chief of the bureau.

Upon his professional skill and the efficiency of his department depended the readiness of the fleet, and the rapid and safe transportation of our armies to France. Our vessels and personnel were ready mainly because Admiral Griffin and his staff had anticipated the emergency and had plans completed to meet it.

Some idea of the magnitude of this work can be obtained by considering that the navy had under its care the machinery of nearly 2000 vessels, of which 570 were of our regular navy. The aggregate horsepower of these ships is about six and one-half million. If we add to this the total of the number of vessels under construction, more than 400 could be added and the aggregate horsepower increased to eleven million.

The work of the Bureau of Steam Engineering covers the motive power of all naval vessels, and includes also the electrical machinery, the radio telegraph and machinery for naval air craft. The first installation of electric drive in the navy, that on the battleship "New Mexico," and the rehabilitation of the damaged machinery of the interned German ships, came within the scope of the bureau.

Admiral Griffin is a man of culture, a writer of excellence upon engineering subjects, and is extremely modest by nature. He has never been one to advertise his work.

He was born in Richmond, Va., in 1857, and graduated from Annapolis in the class of 1878.

Fiftieth Anniversary of Western Society of Engineers

On June 27 and 28 the Western Society of Engineers celebrated its fiftieth anniversary. The society was organized May 25, 1869. It was known as the Civil Engineers' Club of the Northwest until 1880, when it was reorganized and its present name adopted. In the society rooms in the Monadnock Building, Chicago, a meeting was held at 3 o'clock at which a résumé of the society's history was given by Secretary Nethercut, who mentioned specifically the founders, Messrs. Mason and Paine, and reviewed briefly the work of all charter members. Following there was a brief review of the development of the society, including statistics on membership, which, roughly, up to 1909 had doubled every ten years. For the last ten years it has remained practically stationary in the vicinity of 1100, the lack of growth being due principally to the activity of national societies forming local chapters in the city. Some of the notable achievements of the society were mentioned briefly and some of the recent changes in its work to meet the progressive attitude of the day were enumerated.

In conclusion the secretary could see no good reason for 13 chapters of national societies and several distinct local engineering societies in the city. There should be one technical society in Chicago common to all, the Western Society of Engineers acting as a center. It was estimated that an all-embracing society of this character could have at least 5000 members, with an engineering building in prospect to serve all branches, of engineering. There was no intention to limit the local membership of the national societies, for such an organization as outlined would stimulate their growth.

Engineering development of the past half century was a topic that had been divided into several subdivisions and assigned to a number of speakers. S. O. Dunn, editor of *Railway Age*, reviewed the developments in railway engineering. J. R. Bibbins spoke on the great advance in steam engineering. Electric light and power was covered by James R. Cravath. Electrical communication, including the telephone and the telegraph, was covered by F. F. Fowle, and John W. Alvord in a few concise statements gave the high lights in sanitary engineering during the period under discussion.

On Friday evening there was a reunion smoker, including motion pictures, messages from past presidents, instrumental music, songs by the Universal Quartet, community singing, refreshments and an address by Col. Henry A. Allen on the work of the 108th Engineers. The colonel reviewed the training period, the trip across to France and the military experience of the regiment in the war zone. Particular reference was made to the colors that had been presented to the regiment by the Western Society of Engineers.

In the history of the society there have been 39 presidents, of whom 33 were living and 12 were present. Of the latter each addressed the meeting briefly, bringing up reminiscenses of the past. Others who could not attend had forwarded messages for presentation.

Saturday, June 28, was given over to a family-reunion basket picnic at The Dunes, for which an excellent program had been prepared. There were games, races and bathing. The picnic proved to be a most enjoyable occasion.

Labor Situation in New York State

Some interesting facts concerning the factory employment situation are made public in a bulletin issued by the Bureau of Statistics and Information of the New York State Industrial Commission. An abstract of the bulletin follows:

After declining steadily since last November, the number of employees in the factories of New York State remained practically stationary from March to April. This seems to indicate that the readjustment from a war-time basis to the regular business of peace-time has been largely accomplished. The number of workers is now 8 per cent. lower than in November, but is still 11 per cent. higher than the pre-war level, and no prospect of much further reduction appears probable at this time.

The total of wages paid by the factories of the state was about 1 per cent. lower in April than in March. The total of payrolls is 11 per cent. lower than in December, 1918, but 95 per cent. higher than in June, 1914.

Some reduction in hours are still being reported, but no reduction in wages.

The cost of food is now 84 per cent. above the level of June, 1914, and the average earnings of factory workers have increased 74 per cent. For industry groups this increase in average earnings ranges from 53 per cent. for the printing and paper group to 87 per cent. for stone, clay and glass and for paper manufacture.

The employment situation in the state in April shows that for every 100 workers called for, 80 registered as seeking employment, against 89 in March and 96 in February. Only in building work and clerical occupations were there more applicants than jobs. All branches of manufacturing show more positions open than applicants.

Water-Power Bill Before Congress

Representative Esch, of Wisconsin, chairman of the Joint Water Power Committee of the House of Representatives, began the first debate in the present extra session of Congress on the subject of water-power legislation, in the House, June 27, when he presented for the consideration of the House the bill adopted by the committee (H.R. 3184) to create a Federal power commission and to define its powers, duties, etc.

The debate continued for two hours, although no action was taken upon the bill. Representative Sims, of Tennessee, former chairman of the Joint Water Power Committee in the previous Congress, was in charge of the presentation of the views of the Democratic minority in the House, although he announced that he was in favor of the bill and concurred in the statements Representative Esch made in presenting the bill.

The presentation by Mr. Esch of the arguments in favor of the passage of the legislation marked the first appearance in charge on the floor of the House of Mr. Esch. He said:

> If we had had this legislation six or eight years ago, we would have been in an entirely different situation when we entered the war. One of the great needs of the war, one of the great shortages of the war, was the matter of power; had the situation been such as might have been possible under the bills which have heretofore been passed in this House, we would not have suffered from that shortage as we did, and we would have had greater production. I hope the time is near at hand when the repeated efforts from the House of Representatives to secure adequate water power legislation may bear fruit.

During the general debate that followed, Representative Stevenson announced that he intends to offer an amendment altering the method provided in the bill for the condemnation of property. This brought about a general discussion by Representative Black, Representative Kinkaid and others as to the questions of eminent domain and rights of the state and the Federal governments under that principle.

Representative Ferris called the attention of the House to the fact that on Feb. 28 last, the House "after very full and careful consideration of the conference report passed this identical bill by a vote of 203 for to 65 against," showing, he said, that at that time, "after long consideration the sentiment of the House was overwhelmingly for the bill," and he assumed that it is now.

Representative Ferris said he was proud that the House is getting up the water-power legislation early in the session and that he hoped the Senate will take it up at once. "For example," he said, "the engineers who have examined the subject assert that we have in the United States potential water power ranging all the way from 35,000,000 to 200,000,000 hp. of hydro-electric energy. The fact remains that only 6,000,000 hp. of that entire amount is in use, and that the rest is running idly to the sea, doing no one any good." Mr. Ferris made a few suggestions as to possible alterations in the bill, after saying that there is apparently not to be much controversy about the bill in the House. He called attention to the necessity of avoiding any changes or modifications which are vital, and which, although slight in appearance, might be far reaching in effect.

The more optimistic friends of the proposed water-power legislation had hoped that the House would pass the bill unanimously and with practically no debate, but no vote was reached. Representative Esch proposes to press for the passage of the legislation.

The Decline and Ultimate Production of Oil Wells

A bulletin by Carl H. Beal has been issued by the Department of the Interior in which he states that the limit of production of petroleum in this country is being approached, and while new fields doubtless are yet to be discovered, the yearly output will inevitably decline. More wells will be driven and every effort to discover and develop new fields will be made, but while an increase may result for a time, such increase will become impossible after a certain point is reached.

At present the country is facing a serious shortage of petroleum. In order to meet this emergency the Bureau of Mines has been carrying on investigations for a number of years. However, the field covered by these tests has been limited to actual producing problems such as drilling, efficient recovery of oil, storage, etc. But these investigations have failed to touch upon the matter of ultimate production, that is, upon how much oil a well or group of wells will produce in the future, and at what rate.

Formerly, this question bothered the producer not at all. Undrilled acreage was plentiful, so little or no attention was directed to conservation and future production. Recently, the oil industry has been forced to cut down operation to a more conservative level. They are demanding a more complete knowledge of the probable future production of wells and oil lands. Probably, as fewer and fewer large oil fields are discovered, the oil industry will more and more seek the aid of science. The technical man will find his services needed in every branch of the industry, especially in the selection of probable new oil lands, and in determining the value of producing and prospective oil fields. When the information as to capacity and rate of production can be given with approximate exactness, the producer will be able to obtain a fairly trustworthy idea of his future yearly income, and the worth of his property, as well as that of other oil fields he may contemplate purchasing.

It is going to be the duty of the petroleum engineers to obtain these facts. But from where? At present suitable statistics upon which to base such deductions are mostly in the hands of competing companies. Undoubtedly, such material can best be collected, analyzed and published through the medium of the Federal Government.

But most petroleum engineers lack training in the principles of valuation. This is not surprising. This phase of the work is comparatively new, but none the less the question of valuation is going to be one for the petroleum engineer to answer. His familiarity with the origin and accumulation of oil and gas and their relation to geologic structure is of first importance for the scientific valuation of producing and prospective oil lands. It is up to the engineer. He should strive to meet the probable requirements of this specialized branch of petroleum technology.

Boiler Explosion at Des Moines

A portable boiler exploded June 14, in the plant of the Des Moines Asphalt Paving Co., Des Moines, Iowa, slightly injuring two workmen. The building over which the boiler was stationed, together with the engine, was totally wrecked. The damage, not including the boiler, is estimated at $500. The rupture occurred at the first girth seam, some of the rivets shearing, and the plate breaking clean in other places where the sheet had crystalized. The rupture extended about one-third of the circumference of the 36-in. shell. The thickness of the plate was seven-sixteenths inch. According to the man in charge the boiler had been in use fifteen or twenty years. It did not leave its setting.

At a recent meeting of the Diesel Engine Users Association of London, England, the subject of insurance against breakdown occupied the attention of the members. Some time ago the association adopted a standard form of insurance policy against breakdown of this type of machine, and one of the conditions of the policy is that in case of disagreement of the interpretation of the policy the matter shall be submitted for arbitration to a special committee of the Diesel Engine Users Association, whose decision is to be final and binding on both parties.

A large air chamber is often necessary on a pump or suction line when the line is long and the lift is high.

Personals

A. P. Little, formerly of the Bureau of Standards has been appointed professor of electrical engineering in the Colorado School of Mines.

George S. Cooper, formerly mechanical engineer with the Buckeye Engine Co., of Salem, Ohio, is now research engineer for Hooven, Owens, Rentschler Co., of Hamilton, Ohio.

G. D. Farnham, formerly with The Westinghouse Church Kerr Co., of New York City, has accepted a position with the McCann-Harrison Co., of Cleveland, Ohio, as chief engineer of its power and heating department.

Charles H. Garlick has been reappointed state steam boiler inspector for Allegheny County, Penn., by Gov. William C. Sproul. Mr. Garlick has held this position under three governors during the past seven and a half years.

L. W. W. Morrow has been made assistant professor of electrical engineering at Yale University. Professor Morrow was in charge of one of the divisions of the Signal Corps Training School for Officer Candidates.

Raymond G. Sherman has been promoted from the position of superintendent of the Deerfield River Power Co. to that of superintendent of the Connecticut River Power Co. Both companies are under the management of the New England Power Co.

J. C. Walton, consulting engineer, has been elected mayor of Oklahoma City, a town of 100,000 inhabitants. His efficient administration as Comissioner of Public Works resulted in his choice as mayor when his term as commissioner was but half completed.

Stanley J. Quinn, secretary of the American Manufacturers' Export Association, has resigned to accept a position with one of the members of the association. Robert F. Volentine who, for the last several months has been associated with the Brooklyn Chamber of Commerce, was elected as his successor.

H. M. Turner has been made assistant professor of electrical engineering in the Sheffield Scientific School. Profesor Turner has been connected with the department of electrical engineering of the University of Minnesota, and came to Yale last fall as an instructor in the Signal Corps Training School.

W. A. Moore, who has been connected with the piping department of the M. W. Kellogg Co. for a number of years, and during the war was chief inspector in the Ordnance Department, has assumed charge of the New York office of the M. J. Dougherty Co., power piping contractors, North American Building, Philadelphia, Penn.

Samuel F. Joor, a well-known consulting engineer, of Chicago, has joined the American Steam Conveyor Corp., Chicago, in the capacity of sales engineer. Mr. Joor has had wide experience in the conveyor field, at one time being Western manager and sales engineer of the Jeffrey Manufacturing Co., and previous to that with the Link Belt Co.

G. F. Wittig has been made assistant professor of electrical enginering in the Sheffield Scientific School of Yale. He had been connected with the Signal Corps Training School for Officer Candidates for the past year. Professor Wittig was formerly connected with Westinghouse Church Kerr & Co. Later he was professor of electrical engineering at the University of Pennsylvania. He is a graduate of Columbia.

George Ellery Hale, director of the Mount Wilson Observatory and foreign secretary of the National Academy of Sciences, who has been for the last ten years a correspondent of the Academic des Sciences, Institut de France, has received the unusual honor of election as Associe Etranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The foreign associates are limited to twelve, and the high distinction has been held by only two Americans—Simon Newcomb and Alexander Agassiz. The National Research Council upon the presentation and acceptance of Dr. Hale's resignation as its chairman and the election of James R. Angell as his successor, created and bestowed in perpetuity upon Dr. Hale the title of Honorary Chairman in recognition of his services to the National Research Council and to science and research by indefatigable efforts that have contributed so largely to the organization of science for the assistance of the Government during the war, and the augmentation of the resources of the United States through the newly intensive cultivation of research in the reconstruction and peace periods that follow.

Engineering Affairs

Michigan State Association N. A. S. E., will hold its annual convention at Grand Rapids, July 23-25.

Wisconsin State Association, N. A. S. E., will hold its annual meeting at Madison, July 30, 31, August 1.

Minnesota State Association, N. A. S. E. convention will be held this year at Minneapolis, August 6-8.

Universal Craftsmen Council of Engineers will hold its annual convention at Newark, N. J., August 5-8. The Robert Treat Hotel will be the headquarters, and in this building the sessions of the delegates and the mechanical exhibit of the supply men will take place.

Phoenix Association No. 24, N. A. S. E. held its annual outing and field day at the American Park, College Point, N. Y., on Sunday, June 29. The outdoor sports ended with a baseball game between the engineers and supply men, the former winning by the score of 12 to 6. Fully 250 enjoyed the dinner that followed.

The American Association of Engineers has chartered during the past week clubs at Tulsa, Okla., Eureka, Col., Norfolk, Va., Fond du Lac, Wis., and Akron, O. The following are the officers at these clubs: Tulsa Club, C. C. Toomey, Carter Oil Co., Tulsa Okla., Pres. Eureka Club, F. W. Howard, Secy., Korbel, Cal., Fond du Lac Club, O. J. Husemeier, Pres., Box 85, Fond du Lack, Wis. Akron Club, R. B. Jackson, Secy., 395 Boyle St., Akron, Ohio.

Tidewater, Va., Valley Chapter, A. A. E., has elected the following officers: President, W. P. Tunstall; secretary, R. W. Bonney; treasurer, G. H. Massey. The Tidewater chapter includes in its jurisdiction the following cities: Norfolk, Portsmouth, Suffolk, Newport News, Hampton, Phoebus, Fortress Monroe, Army Supply Base and Navy Supply Base, Va.

Miscellaneous News

The Electrical Exposition and Motor Show is to be resumed this year, opening at the Grand Central Palace, New York City on Sept. 24. This will be the first show since 1917, last year's display having been omitted on account of the war. The Grand Central Palace was used during the war as a debarkation hospital.

Railroad Engineers Salaries.—The matter of proper salary for engineers in railroad service which the American Association of Engineers presented to the Wage Board of the United States Railroad Administration is now under consideration, and, according to a letter received by the association secretary, will be brought to an early conclusion.

Prospects for Foreign Business—C .R. Messinger, vice-president of the Chain Belt Co., Milwaukee, who recently returned from a three months' investigation of business conditions in Europe, believes that the United States will get the big bulk of European trade after business conditions become more normal. At present European business is marking time and the general feeling seems to be that even the signing of the peace terms will not bring about any great change immediately. When things do open up, however, American manufacturers will be found in better shape than their European competitors and should get the bulk of the business, though liberal credit terms will be necessary. C. L. Pfeifer, treasurer of the same company, has just returned from a several weeks' stay in Cuba where he studied business conditions generally. In his opinion Cuban business is in a very prosperous condition, with indications that this will continue for perhaps three years. The country has just broken all records in its sugar crops, and planters feel that the succeeding crops will be still greater.

The Fifth National Exposition of Chemical Industries will be held in the Coliseum and First Regiment Armory, Chicago, during the week of Sept. 22, and will be a convocation of societies in connection with the exposition. The American Institute of Mining Engineers will occupy the stage for the first part of the week, later the American Ceramic Society, the American Electrochemical Society, and the Technical Association of Pulp and Paper Industry. Among the interesting features of the exposition program will be a symposium on "Safety in the Plant and Mine," with speakers of authority in this work under the chairmanship of M. L. Leopold, safety engineer of the United States Bureau of Mines, and in the evening there will be shown a series of motion pictures of safety work in plant, field and mine, made in industrial plants all over the country under the supervision of Government agents. Even in motion pictures as in all important improvements in plant machinery and products, the exposition is outstanding as the place of introduction to the public of the newest and most recent developments. Each improvement of the projectoscope in motion-picture projection has been reserved for first public demonstration at the exposition and again this year will have the latest developments in this field of endeavor.

Business Items

Mayer & Valentine, heating ventilating and power plant engineers, announce the opening of an office at 615 Bangor Building, Cleveland, Ohio.

The Hammel Oil Burning Equipment Co., Inc., of Providence, R. I., has opened a New York City office at 110 West 40th St., with James J. Tyrrell in charge.

The Roberts Co. has opened an office at 1049 Drexel Building, Philadelphia, as consulting and contracting mechanical engineers and general machine designers.

The Bound Brook Oil-Less Bearing Co., Bound Brook N. J., is having built a new machine shop and office building of concrete and steel construction on Lincoln Boulevard, adjoining the present foundry.

The Walter A. Zelnicker Supply Co. has added 2000 sq.ft. to its present office space at 325 Locust St., St. Louis, Mo. This improvement will enable this organization to continue to efficiently render Zelnicker service.

The Midwest Engine Co., of Indianapolis, Ind., announces the opening of four branch offices as follows: Jacksonville, Fla., with D. J. Carrison in charge, with offices in the Florida Life Building; El Paso, Tex., offices at 303 Caples Building, with Chester B. Loomis in charge; New Orleans, La., offices at 617 Maison Blanche Building, with J. R. Lowe in charge; New York City, at 111 Broadway, with B. H. Downing in charge.

The Steam Motors Co., Springfield, Mass., announces that the following have been appointed as its representatives to cover their respective territories: K. N. Jackson, Monadnock Building, Chicago, Ill.; F. H. Mason, Moffat Building, Detroit, Mich., Morgan-Gerrish Co., 501 So. 6th St., Minneapolis, Minn.; R. T. Coe, Insurance Building, Rochester, N. Y.; Southern Engineering Co., 425 Gravier St., New Orleans, La.

The Harrison Safety Boiler Works, Philadelphia has acquired the Monash line of pressure-reducing valves and pump governors, formerly manufactured and sold by the Monash-Younker Co., of New York and Chicago. The purchase includes a stock of manufactured parts and valves, drawings, patterns, trade-mark, and good will. The Harrison Safety Boiler Works will manufacture and market the valves under the trade name "Cochrane-Monash," and will supply repair parts for valves now in use.

S. F. Bowser Co., Ltd., of Toronto, Ont., has been recently reorganized to operate as a strictly Canadian organization, financed and managed under Canadian control, and as a separate institution from the home office at Fort Wayne, Ind., under which it was formerly operated. H. C. Christie, who has been a number of years connected with the Canadian factory of the company as sales manager, has been elected manager, with E. E. Cummings as factory manager. The other officers are: S. F. Bowser, president; S. B. Bechtel, vice president; H. J. Grosvenor, secretary and W. G. Zahrt, treasurer. The policy of the firm under the new management will be along the same lines as heretofore.

Trade Catalogs

The Standard Spiral Pipe Works, Chicago, Ill., has issued a 46-page catalog (No. 7) fully describing and illustrating the company's reinforced spiral pipe. List prices of pipe of various sizes and standards are given, as well as of other pipe fittings, etc. A couple of pages of useful engineering information are included.

Lagonda Automatic Cutoff Valves. The Lagonda Manufacturing Co., Springfield, Ohio. Catalog S-2. Pages 32; 6¾ x 10 in. This catalog fully describes and illustrates the various types of Lagonda automatic valves, and shows diagrams of the valves installed in various vertical and horizontal positions. A copy may be had free upon request.

The Northern Equipment Co., Erie, Penn., has just published an eight-page bulletin, 8½ x 11 in., embodying specifications for the Copes system of boiler-feed regulation. This bulletin discusses the principle of operation, heat storage reduction of furnace temperature fluctuations, thermostat, standard dimensions and drilling, the Copes steam pump governor, etc.

The Bastian-Blessing Co., Chicago, has issued a bulletin entitled "A New Principle in Welding and Cutting Apparatus." Rego welding and cutting outfits were first placed on the market about a year ago and have made good to such an extent that they are now being used in nearly all large cities. Rego torches, which have eliminated the flashback, are also described in this bulletin. A copy may be had free upon request.

Lea-Courtenay Co., New York City, has issued a 27-page bulletin "C," entitled "Artificial Draft for Economy and Greater Boiler Capacity." It contains seventeen illustrations showing the application of this system, called the "Cotton System," to various types of boilers. Bulletin "S," by the same company, describes and shows various installations of the Cotton jet stoker; and Bulletin No. 210 the Cotton blower, grate, ashdoor furnace and smokeless furnace.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6.05	$7.90	Pea	4.90	6.65
Egg	5.95	7.80	Buckwheat	3.40	5.15
Stove	6.20	8.05	Rice	2.75	4.50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.75 @ 2.95	2.95 @ 3.25
Clearfield County	2.50 @ 2.75	2.80 @ 2.95
Reynoldsville	2.50 @ 2.75	2.75 @ 2.95
Quemahoning	2.65 @ 2.85	2.95 @ 3.10
Somerset County (best grades)	2.50 @ 2.75	2.95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2.35	2.50 @ 2.75
Western Maryland	2.25 @ 2.50	2.50 @ 2.75
Fairmont	2.00 @ 2.25	2.35 @ 2.50
Latrobe	2.10 @ 2.25	2.25 @ 2.40
Greensburg	2.25 @ 2.55	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the **3% war freight tax.**

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.05	7.90	Rice	2.75	3.65
Stove	6.30	8.15	Boiler	2.50	3.50
Nut	6.40	8.25	Barley	2.25	3.15
Pea	5.00	6.60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County		Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....	.....
Williamson County			
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	....
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

N. Y., Belport—The Northern New York Utilities, Inc., plans to build a high tension steel tower transmission line from the company's power house, here, to Towville, about 20 miles. Estimated cost, $200,000. H. G. Davis, Light and Power Bldg., Watertown, Ch. Engr.

N. Y., Binghamton—The Binghamton Light, Heat & Power Co., 172 Washington St., is in the market for a 3000 kw. generator and condenser and a 5000 kw. generator and condenser. R. N. Hodgson, Binghamton, Gen. Mgr.

N. Y., Buffalo—The Robertson Cataract Co., 151 West Mohawk St., will install small boilers in connection with the 6 story, 50 x 100 ft. warehouse which it plans to build. Estimated cost, $80,000. R. L. Fayfield, Iroquois Bldg., Arch.

N. Y., Canton—The Madrid Springs Co., Madrid Springs, is in the market for transmission machinery in connection with rebuilding its factory here, recently destroyed by fire, entailing a loss of $10,000.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a power distributing system at the Naval Air Station here. Estimated cost, $60,000. Specification No. 3958. Noted July 1.

S. C., Orangeburg—The city plans election soon to vote on $70,000 bonds for enlarging and installing additional machinery at the electric power plant. E. Hawes, City Engr.

La., New Orleans—The U. S. Naval Station plans to build a central power house on the Mississippi River. Estimated cost, $120,000. Engineering Dept. of the U. S. Navy, Algiers Station, Engrs.

Ohio, Cleveland—The Theunor Norton Provision Co., West 63rd St. and Stock Ave., will install a cold storage plant in connection with building an addition to its factory. Estimated cost, $30,000.

Mich., Detroit—Herman Kramer & Sons, 1697 Gratiot Ave., will install a complete steam plant for heating, motor driven fans and air compressor in connection with the 2 story, 80 x 230 ft. theatre and stores which they plan to build. Total estimated cost, $250,000. C. H. Crane and E. G. Kiehler, 2325 Dime Bank Bldg., Detroit, Arch.

Ill., Chicago—The Mid City Cold Storage Co., c/o A. A. Salzman Engineering Co., Engr., 30 North La Salle St., plans to build a 5 story cold storage plant. Estimated cost, $1,000,000.

Neb., Fall City—The city plans to build a new boiler plant for the water works and electric system. Estimated cost, $50,000.

Neb., Omaha—J. Latenser & Sons, Archts., 632 Bee Bldg., will receive bids until July 20 for the construction of a 1 story, 44 x 110 ft. boiler house on 42nd St. and Dewey Ave., in connection with the University of Nebraska College of Medicine and Hospital, here. Estimated cost, $75,000.

Mo., St. Louis—The Mineral Refining & Chemical Corp., Iron Mountain Tracks and River Des Peres, is in the market for 1 or 2 boilers of 500 aggregate hp. A. Alayo, Gen. Mgr.

Cal., Bakersfield—A. L. Fellows, Federal Irrigation Engr., has reported the project to irrigate lands in Kern River Delta Dist. feasible, and the interested parties have appointed a committee headed by H. T. Miller, Bakersfield, to perfect an organization of irrigation district under state law. The engineer has recommended the acquisition of water rights and distributing systems in the district, construction of a drainage ditch, pumping plants, development of power, etc. District will comprise 684,160 acres, and will probably be known as the Kern River Delta Irrigation District.

Cal., Haywood—The city plans election soon to vote on $228,000 bonds for the construction of a waterworks system, including wells, distributing system, pumps, etc. Olmsted & Gillelen, 1112 Hollingsworth Bldg., Los Angeles, Engr.

Cal., Lancaster—The Board of Supervisors, Los Angeles, plans to form waterworks Dist. No. 4 embracing the town of Lancaster; to include wells, pumping plant, etc. Estimated cost, $30,250. A. M. McPherson, Clk.

Cal., Los Angeles—The Board of Supervisors will soon award the contract for the construction of a psycopathic ward building at the county farm. Plans include the construction of a boiler plant. A. M. McPherrin, Clk.

Cal., Los Angeles—The city voted $135,000 bonds for the construction of a sewer system. Plans include the installation of pumps, etc. W. T. Knowlton, City Engr.'s office, Engr.

Cal., Sacramento—The Board of Supervisors plans to build a 2 story power house and service building on the County Hospital Grounds. Plans include the installation of boilers for heating the entire group of buildings. Estimated cost, $100,000. R. A. Herold, Forum Bldg., Arch.

Cal., San Diego—The San Diego Ice & Cold Storage Co. is having plans prepared for the construction of a 4 story, 100 x 200 ft. cold storage plant on 8th St. and Imperial Ave. Estimated cost, $25,000.

Que., Montreal—The Dupre Iron Works, Ltd., is in the market for boilers and dynamos in connection with the factory which it plans to build. P. L. Dupre, 15 Blvd., St. Laurent, Arch.

Ont., Acton—The town has engaged James, Loudon & Hertzberg, Engrs., 36 Toronto St., Toronto, to make surveys and sumbit preliminary report for a complete new waterworks system. Plans include pump house, wells, distributing mains, etc. Estimated cost, $90,000.

Ont., Aurora—W. J. Bassett, Mayor, will receive bids until July 11 for a centrifugal pump having a capacity of 750 gals. per minute, and a gasoline engine. James, Loudon & Co., 36 Toronto St., Toronto, Engr.

Ont., Teeswater—The Town Council plans to install a hydro-electric system for lighting and power distribution system, and is in the market for all equipment for same. A. Flint, 190 University Ave., Toronto, Engr.

Ont., Toronto—The Hydro Electric Power Commission of Ontario, University St., plans to install 5 units (about 60,000 h.p.) power plant and a 200 ft. concrete dam, 43 ft. high, at Cameron Pool. F. A. Hogg, Toronto, Engr.

Ont., Wingham—The Town Council plans to install a hydro-electric system for lighting and power distribution system, and is in the market for all equipment for same. A. Flint, 190 University Ave., Toronto, Engr.

Sask., Regina—The city is in the market for Diesel and gas engines for the power plant.

CONTRACTS AWARDED

Conn., Hartford—The Automatic Refrigerating Co., 89 Willow St., has awarded the contract for altering and building a 1 story, 23 x 76 ft. addition to its plant on Capitol Ave., to Wise & Upson, 36 Pearl St. Estimated cost, $30,000.

Conn., Stamford—The Diamond Ice Co., Main St., has awarded the contract for the construction of a 1 story, 26 x 100 ft. addition to its plant, to the Vuono Construction Co., Bank Bldg. Estimated cost, $15,000.

N. Y., Ossining—C. F. Rattigan, Supt. of State Prisons, Hall of Records Bldg., Center and Chambers St., New York City, received lowest three bids for installing boilers at the Sing Sing Prison here, from J. W. Danforth Co., 70 Ellicott St., Buffalo, $41,847; Lynch & Woodward, 287 Atlantic St., Boston, Mass., $42,945; A. B. Barr & Co., Inc., 30 East 42nd St., New York, $45,800. L. F. Pilcher, Capitol, Albany, State Arch. Noted June 17.

D. C., Washington—The Treasury Department, Office of the Superv. Arch., received bid June 26 for the construction of a boiler house, cafeteria, etc., at the War Industries Building, from W. P. Lipscomb, 1406 G St., N. W., Washington, D. C. (30 days).

W. Va., Benwood—S. G. Smith, Receiver, Wheeling, has awarded the contract for installing motors and pumps at the water works, to the Dravo Doyle Co., Diamond Bank Bldg., Pittsburgh, Penn. Estimated cost, $5743.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received bids for installing boilers and super-heaters at the Navy Yard here, (work complete), from the Heine Safety Boiler Co., 1120 Pennsylvania Bldg., Washington, D. C., $42,850, (140 days); Edgemoore Iron Co., Edgemoore, Del., $45,217, (120 days); J. L. Skeldon Engineering Co., 242 Water St., Toledo, Ohio, $51,922. Specification No. 3707. Noted Dec. 10.

S. C., Paris Island—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for building an extension to the power house here, to the Newport Contracting & Engineering Co., Law Bldg., Newport News, Va. Estimated cost, $10,385 (60 days).

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., received ids for the construction of a power house and installing electric operating equipment and fire protection system at the Naval Air Station here, (work complete), from the South Florida Contracting and Engineering Co., Key West, $97,000, (180 days); Newport Contracting & Engineering Co., Silsby Bldg., Newport News, Va., $112,140 (180 days). Noted July 1.

Ohio, Cincinnati—The Treasury Department, Superv Arch.'s Office, has awarded the contract for installing 2 new boilers in the post office and custom house here, to the Heine Safety Boiler Co., 1432 Union Trust Bldg., Cincinnati, $20,430. Noted July 1.

Ohio, Springfield—J. Leffel & Co., Lagonda Ave., has awarded the contract for the construction of a factory on East St., to the Concrete Steel Construction Co., 415 Mitchell Bldg.; plans include a 50 x 150 ft. power plant. Total estimated cost, $500,000.

Wis., Milwaukee—H. C. Fischer & Son, 532 Reed St., has awarded the contract for the construction of a cold storage plant, to H. Koening, 892 Layton Blvd.; contract for refrigeration equipment has been awarded to the Vilter Manufacturing Co., 872 Clinton St., Milwaukee. Estimated cost, $10,000.

Wis., Milwaukee—The T. M. E. R. & L. Co., Public Service Bldg., has awarded the contract for the construction of a 2 story, 60 x 80 ft. power station on 26th and Burnham St. to R. L. Reisinger, First National Bank Bldg.

Wis., Superior—The Board of Education has awarded the contract for the construction of a 2 story, 80 x 200 ft. school with 1 story, 56 x 70 ft. wing, to Hill & Dauplaise, Superior. Plans include the construction of a power house. Total estimated cost, $174,500.

Wis., West Allis—The Board of Education has awarded the contract for the construction of a power house and high school on National Ave., to the Kroening Construction Co., Majestic Bldg., Milwaukee. Estimated cost, $300,000. Noted June 24.

Mo., St. Louis—The St. Louis Manufacturing Corp., 5401 Bulwer St., has awarded the contract for the construction of a 2 story, 96 x 150 ft. power house at 5405-11 Natural Bridges, to A. H. Haeseler B. & C. Co., Wainwright Bldg. Estimated cost, $125,000.

Mo., St. Louis—The St. Louis Wholesale Cut Flowers Co., 1410 Pine St., has awarded the contract for the construction of a refrigerating plant at 1408 Pine St., to the J. Grewe Construction Co., Century Bldg. Estimated cost, $19,000. Noted Apr. 22.

Ariz., Florence—The city has awarded the contract for the construction of a power house and pipe lines, to C. Fisher, 845 North 6th St., Phoenix; for pumping machinery, engine and switchboard, to the Dousman Warner Co., $26,980.

Ore., Prineville—The Standard Oil Co. has awarded the contract for the construction of a pump house, three 16,000 gal. galvanized iron tanks, garage, etc., to O. Wilson, Prineville.

Cal., Anaheim—The City Trustees have awarded the contract for installing pump at the waterworks, to the Krogh Pump & Machinery Co., Los Angeles. Estimated cost, $2410. E. B. Merritt, City Clk. Noted June 3.

Cal., Lemon—G. C. Power has awarded the contract for the construction of a 1 story, 140 x 250 ft. fruit packing house, boiler house, etc., to W. Slater Co., 2314 Santa Fe. Ave., Los Angeles. Estimated cost, $70,000.

Cal., Vernon—The California Provision Co. has awarded the contract for the construction of a 2 story, 88 x 142 ft. packing house and refrigeration building, a 20 x 32 ft. boiler house, and 32 x 32 ft. office building, etc., to C. B. Harp, 1102 Baker-Detwiller Bldg., Los Angeles. The company will soon award the contract for furnishing machinery and equipment, including a 25-ton refrigeration plant, boilers, etc. Total estimated cost, $150,000.

Que., Three Rivers—The Three Rivers Cold Storage Co. has awarded the contract for the construction of a cold storage plant, to Arsenault & Plamondon, Ltd., 70 St. James St., Montreal. Estimated cost, $75,000.

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